REVIEW OF OFFSHORE DEVELOPMENT TECHNOLOGIES
INFORMATION, SCIENCE AND TECHNOLOGY AGENCY
BRITISH COLUMBIA
TF12101

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EXECUTIVE SUMMARY

The Province of British Columbia imposed a moratorium on exploration drilling in 1959 on the coastal waters between Vancouver Island and the border of Alaska and British Columbia. The moratorium was temporarily lifted in 1966 to permit the drilling of 14 exploratory wells. In 1972, both the Government of Canada and the Province of British Columbia established the moratorium. Consideration was given to lifting the moratorium in 1984 so that petroleum companies holding leases in the region could undertake exploration programs. In order to make an informed decision, the two governments appointed a five-person panel to hold public information meetings throughout northern British Columbia during the fall of 1984 and 1985. Acting as a proponent was Chevron Canada Resources Ltd. with Petro-Canada initially participating, but withdrawing in November 1984.

The report, entitled *Offshore Hydrocarbon Exploration, Report and Recommendations of the West Coast Offshore Exploration Environmental Assessment Panel*, was delivered to both governments by the panel in April 1986. Containing 92 (ninety-two) recommendations, it helped both governments to negotiate a pacific Accord which would have allowed the lifting of the moratorium. However, spills from a tanker as well as a tug in 1989 and subsequent public reaction to these events, persuaded the two governments to continue an indefinite extension to the moratorium with no mechanism for its review.

Given that ten years have past since the last review, the Premier's Advisory Council on Science and Technology has commissioned this study to review the status of existing and future offshore exploration developments in order to update the information available to them.

This study examines the status of the offshore exploration industry in both Canada and elsewhere, particularly as it relates to the issues identified in the 1986 report. Advancements are outlined in offshore technology and physical, biological and socio-economic offshore management and monitoring environments. Information gaps are identified that might prevent a full assessment of exploration risks and impacts. While the consultants have been asked to focus on the exploration phase, it is difficult to isolate exploration from production since few oil companies will spend the necessary capital for exploration if they are not allowed to develop. Therefore, significant improvements are covered for all phases of the industry, but with emphasis on the exploration phase.

The study points out the difference between the oil industry in the North Sea and in Atlantic Canada. The North Sea oil and gas industry which shares jurisdiction between Norway and the United Kingdom exploded almost over night. As a result, a number of learning curves and difficult times were experienced on the way to it becoming a mature industry. Atlantic Canada learned from this and, as well, for a variety of reasons, took almost thirty years to develop to the production stage. This has resulted in a well managed and integrated petroleum industry. As an example, the fishing industry co-exists with the oil industry in both Newfoundland and Nova Scotia as a result of both industries negotiating a set of mutually accepted principles for co-existence as well as individual fishery compensation plans.

In this study the regional setting as described in the 1986 report is updated to determine if any significant changes have occurred. Among the findings is a changing physical environment worldwide as a result of global warming which has, and will continue to have, an effect on

British Columbia. Other changes in northern British Columbia include a decline of almost all fish stocks, particularly all species of salmon, except Sockeye, as well as herring and groundfish. This has negatively affected many coastal communities as well as the sport fishing industry in the area. Most recently the Asian financial crisis has resulted in less demand for many of northern British Columbia's natural resources which affects ports such as Prince Rupert. Despite changes to the economy, the population of northern coastal British Columbia has remained relatively stable with the population on Indian Reserves steadily increasing and the population of coastal communities fluctuating, depending on the stability of the local resource industry. However, recent population statistics do not reflect recent downturns in the economy.

Since 1986 significant changes have also occurred in the management of the offshore oil industry in both Canada and the North Sea. In Atlantic Canada, joint federal/ provincial offshore boards are in place in both Newfoundland and Nova Scotia. These boards regulate all aspects of the industry from the call for nominations for the leasing of offshore petroleum rights through to the granting of production licenses as well as the enforcement of numerous regulations and guidelines governing everything from drilling regulations to environmental effects monitoring. Norway and the United Kingdom are mature oil producing countries with well-established management regimes in place for governing the oil and gas industry.

In the four oil and gas jurisdictions of Newfoundland, Nova Scotia, Norway and the United Kingdom, significant oil and gas activities have taken place during the last ten years. In both Nova Scotia and Newfoundland, the industry has moved from one of exploration drilling to actual production. In Nova Scotia 157 wells have been spudded during the last 30 years, 20 significant discoveries have been declared and more than $4.5 billion has been recently spent for the Sable and Cohasset Panuke commercial fields. In Newfoundland approximately 149 wells have been spudded in the past 30 years, 22 significant oil and gas discoveries have been made and in excess of $9 billion has been recently spent on seismic, drilling and the construction of the Hibernia and Terra Nova production platforms. Georges Bank, located off the southwest coast of Nova Scotia, is a major fishing area, but with potential for significant oil and gas reserves. It has also been under an exploration drilling moratorium for the last ten years. A federal/ provincial appointed panel is now reviewing new information related to Georges Bank as well as holding information sessions and will be making their recommendations to the appropriate Ministers for a decision by January 1, 2000. Information from this process will be useful to British Columbia. Both Norway and the United Kingdom have mature oil industries and are now using new technologies to extend the life of existing fields and are actively pursing new exploration areas.

Significant changes have occurred to the way in which the physical environment is managed. Improved technology has resulted in new and improved forecasting methods, marine dynamics research and geographical information systems. Beyond some specific issues which are outlined in the report, if operators adhere to environmental assessment acts, protected areas' initiatives, environmental guidelines and other required legislation, no major issues or information gaps exist in the understanding of the physical marine environment in the north coast of British Columbia.

Significant changes have also occurred in offshore engineering. The gathering of seismic survey data is more efficient than ten years ago, thereby providing more precise information about the likely presence and location of hydrocarbons. This, in turn, allows for a better selection of correct drilling systems and well design. It has become possible to eliminate

incidents where unacceptable materials enter the sea in all but the most severe incidences. Blow-out can be prevented with the collection of early data, correct selection of equipment and system design, and comprehensive training of drilling operators. Perhaps the most significant advancement made has been in risk management. In the past, the typical approach to safety has been to add protective systems after the main elements of the process facility have been designed. It is now generally recognised that it is better to build in inherent safety systems during the conceptual and detailed design phase, and then provide protection to mitigate any residual risk. Furthermore, safety is now approached through "goal setting" and in a holistic manner as opposed to a prescriptive piecemeal approach. However, it is important to note that exploration is generally of short duration and involves the use of mobile "standard" equipment that has been in worldwide use for many years. Prescriptive regimes are better able to cope with and regulate this mobile market place.

Another significant change that occurred in the last ten years is the incorporation of environmental management strategies as part of an operator's overall management framework. Most offshore oil operating companies include environmental protection and occupational health and safety management within a larger system, the Total Loss Management framework. Furthermore, all companies undertake environmental effects monitoring which identifies potential sources of environmental effects, determines if implemented mitigative actions are effective and provides a foundation for sound adaptive management decisions. While environmental Effects Monitoring (EEM) applies to the production stage because of its long life, companies wishing to conduct short term exploratory drilling off Canada's east coast must apply for registration and authorization from one of the two offshore boards. In these applications, all proposed activities are described, all potential environmental effects are listed and mitigation techniques are outlined.

Although the risk of a blow-out is relatively small, to ensure against on-going damage from a blow-out or spill, marine spill organizations are set up on both the east and west coasts. Furthermore, a series of regulations under the Canada Shipping Act stipulate how to handle bulk oil. As a result of the 1989 Exxon Valdez disaster in Prince William Sound, Alaska, significant research has now been conducted on the fate of oil on numerous species. Environment Canada has also recently published a discussion paper on the fate and effects of marine oil spills. Today, much more is known than ten years ago about what is affected, for how long and how to more efficiently deal with these effects.

Significant lessons have also been learned about the actual socio-economic effects of offshore oil exploration and how both positive and negative effects can be managed. Based on monitoring pre and post-development activity of Hibernia in Newfoundland, the actual negative effects were far less than imagined and the positive spin-offs were greater.

For the exploration phase, work is highly mobile, short term and specialized. As a result limited opportunities exist for direct local jobs, but opportunities exist for research and training institutions and supply and services. Exploration activity is often accompanied by speculative activity on the part of local residents. These speculative responses are often based on a lack of understanding of the industry and its requirements. Thus, for any exploration activity, it will be important for a major information and communications plan to be designed and implemented.

In terms of new management strategies of the last ten years, several have taken place on Canada's east coast which can be applied to British Columbia. Jurisdictions wishing to optimize

the socio-economic effects of the oil industry need both a legal basis for control as well as economic leverage. On the east coast, this has been achieved through the establishment of federal/provincial offshore boards. Local control can be exerted through management of local infrastructure required by the industry.

Perhaps one of the proactive steps a region can take in terms of managing offshore oil activity is to determine what a region wants rather than being reactive and determining how to cope with the activity. In addition, monitoring for the purposes of effective management is another key tool, be it monitoring environmental, social or economic effects. Finally, governments need to determine how they want to balance revenues with direct benefits.

In conclusion, the knowledge base of governments, industry and communities has significantly increased over the last ten years, particularly in negotiating and agreeing to a set of mutual understandings, some of which are legislated, others are guidelines and still others are principles. Regardless of which they are, all three parties operate in respect of one another in order to mutually co-exist.

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1.0 BACKGROUND

The Province of British Columbia imposed a moratorium on exploration drilling for oil and gas in 1959 in the coastal waters between Vancouver Island and the border between Alaska and British Columbia. The moratorium was temporarily lifted 1966 to permit the drilling of 14 exploration wells. In 1972, both the Government of Canada and the province of British Columbia established the moratorium. Consideration was given to lifting the moratorium in 1984 so that petroleum companies holding leases in the region could undertake exploration programs. A five person panel was appointed and held public information meetings and public hearings throughout northern coastal British Columbia during the fall of 1984 and 1985 respectively. Chevron Canada Resources Ltd. acted as a proponent and Petro-Canada initially participated but withdrew in November 1984. Based on information obtained at those meetings, the Panel delivered its report in April 1986. Entitled "Offshore Hydrocarbon Exploration, a Report and Recommendations of the West Coast Offshore Exploration Environmental Assessment Panel", the report contained 92(ninety-two) recommendations covering a broad spectrum of issues including:

- the environmental assessment process;
- seismic surveying;
- routine exploratory drilling and support operations;
- socio-economic effects of routine operations;
- hydrocarbon blowouts;
- fate and effects of oil in the marine environment;
- oil blowout contingency;
- planning and countermeasures, and
- compensation and managing for environmental protection.

On the basis of the report and its recommendations, both the provincial and federal governments decided to negotiate a Pacific Accord which would have allowed the lifting of the moratorium. However, a spill from a tanker as well as a tug in 1981 and the subsequent public reaction to these events persuaded the two governments to continue an indefinite extension to the moratorium with no mechanism for its review. Given that ten years have past since the last review, the Premier's Advisory Council on Science and Technology has commissioned a study to review the status of existing and future offshore exploration developments in order to update the information available.

1.1 OBJECTIVES

The objectives of the study are to provide the Premier's Advisory Council on Science and Technology with the following information:

- the present status of the offshore exploration industry in both Canada and elsewhere;
- information regarding the status of offshore issues elsewhere as they relate to issues on the west coast of British Columbia as identified in the 1986 panel report;
- a review of recent advancements in the field and experience in other jurisdictions which would be applicable to British Columbia, and
- identification of information gaps that might prevent a full assessment of risks and impacts.

1.2 MANDATE

While this study focuses on issues and technologies relevant to potential development in the

British Columbia offshore, the study is not geographically restricted. In fact, the key objective is to review current industry practice, policy, technology and issues on the basis of offshore oil and gas exploration and development activity in other locations and then interpret these matters in the British Columbia context.

The topics covered in this report are multi-disciplinary, spanning the physical, biological and socio-economic environments and touching upon oilfield engineering practices. Information has been assembled from literature and expert opinion, as well as the direct experience of each of the consultants hired for this study, and is presented in a lay-readable manner. For each of the identified topics, the current status is summarized, recent advancements in practice or accepted policy are outlined and recent experiences in related locations are described. Finally, identification of information gaps is provided which might prevent the Province of British Columbia from achieving a full assessment of risks and potential benefits associated with offshore oil and gas development.

While the focus of this study is on the exploration phase of the offshore petroleum industry, it is hard to extract exploration from production since few companies will spend the necessary capital for exploration if they are not allowed to eventually develop a field, assuming hydrocarbons of a commercial volume are found. Therefore, significant improvements are covered for all phases of the offshore industry with emphasis on the exploration phase.

1.3 SYNOPSIS OF BRITISH COLUMBIA PETROLEUM DEVELOPMENTS AND MORATORIUM

In 1958, the first offshore seismic activity took place in the Queen Charlotte Basin off Canada's west coast. By 1961 Shell Canada Limited had begun acquiring exploration permits for offshore areas in Hecate Strait, Queen Charlotte Sound and on the continental shelf off the western coast of Vancouver Island. This led the company to conduct geological mapping and offshore seismic surveys between 1963 and 1967. During the next two years Shell drilled 14 wells, eight of which were in the Hecate Strait - Queen Charlotte Sound. By 1970 Shell had entered into a farm-out agreement with Chevron Canada Resources whereby Chevron would earn an interest in the Shell offshore area by conducting seismic surveys and drilling two deep exploratory wells. However, exploration soon came to a standstill. In 1972 the federal government imposed a moratorium preventing crude oil tankers en route from the Trans-Alaska pipeline terminal at Valdez, Alaska from travelling through the Dixon Entrance, Hecate Strait and Queen Charlotte Sound. Shortly afterwards, the federal government placed a moratorium on drilling in these waters. In 1981, the Province of British Columbia declared the region an Inland Marine Zone. Simultaneously, a moratorium was placed on offshore exploration in Johnstone Strait south of Telegraph Cove and in the Straits of Georgia and Juan de Fuca. These moratoria remain in effect today.

2.0 REGIONAL SETTING - WHAT HAS CHANGED IN TEN YEARS

2.1 PHYSICAL ENVIRONMENT

The north coast of British Columbia has a severe marine environment with extreme storm winds in autumn and winter. The regional setting is well-summarized in the 1986 *Offshore Hydrocarbon Exploration Report and Recommendations of the West Coast Offshore Exploration Environmental Assessment Panel.*

There appears to be no evidence that the physical environment in this area has changed to any great extent in the past 10 years. However, global climate change and the El Niño Southern Oscillation (ENSO) has affected weather patterns worldwide, including British Columbia. These phenomenon are of significant impact to the overall environment.

2.1.1 Global Climate Change

According to a recent report, global climate change has affected British Columbia (Taylor and Taylor, 1997). While temperatures have risen around the world by approximately half a degree, they have increased by one degree in some parts of British Columbia. Precipitation has increased by about 20% on the west coast of British Columbia. Along with other provinces, British Columbia could be subjected to global warming which could increase at a greater rate than has been seen in the last 10,000 years. As well as subtle alterations in temperature and precipitation, climate change could increase the frequency of flooding, droughts and widespread disruptions to forests, fisheries, wildlife and other natural systems.

Listed below are some of the potential impacts of climate change on the north coast of British Columbia that could effect the physical environment, natural ecosystems and economic sectors (Taylor and Taylor, 1997).

2.1.1.1 Physical Environment

X Rising Sea Levels - By 2050 sea level could rise up to 30 centimeters. Warmer ocean waters resulting from climate change would be the main cause of this sea level rise. Tectonic uplift and the continuing crustal rebound from the weight of massive ice sheets that covered the British Columbia coast 12,000 years ago could generally act to restrict the rising seas.

X Spring Flooding - Existing flood protection works may no longer be adequate and spring flood damage could be more severe and frequent along rivers and streams of the coast and throughout the interior of British Columbia

X More landslides - Landslides and debris torrents in unstable mountainous areas of British Columbia and Yukon could become more common as winter precipitation rises, permafrost degrades, and glaciers retreat. Water quality, fish and wildlife habitat, as well as roads and other man-made structures could be at increased risk.

X Coastal risks - Increased sedimentation, coastal flooding and permanent inundation of natural ecosystems could occur in low gradient, intertidal areas.

2.1.1.2 Natural Ecosystems

X Marine life and wildlife threats - Waterfowl that reproduce in areas along the British Columbia coast may experience die back due to a combination of sea level rise and an increase in extreme storm events and storm surges.

X Forest transformation - The diverse biogeoclimatic zones of British Columbia, varying from the frigid alpine tundra zone to the dry bunchgrass zone to the wet coastal western hemlock zone may undergo profound changes.

X Extinction of rare species - Many species of plants and animals that are at their southern geographical limit in British Columbia may disappear. For example, most kelp along the British Columbia coast could be adversely affected by warming water and may be eliminated. Forests could invade sensitive alpine, arctic tundra and shrub tundra communities as treelines move upwards hundreds of metres. Undesirable plant and animal species may invade from the south.

X Migratory bird impacts - Changes in high level winds may hinder the reproductive capacities of migratory birds.

2.1.1.3 Economic Sectors

Fisheries declines - Pacific cod abundance could be reduced. Exotic species could be introduced into warmer rivers and streams where they may displace resident species. Cold water fish such as trout, char, whitefish, and grayling may suffer as water temperatures rise and predators invade from the south. Milder temperatures in northern British Columbia may lead to some increased salmon productivity.

Agriculture Improvement - Where irrigation is not necessary, agriculture could expand and new, higher value crops could be introduced.

Aboriginal Impact - Changes in the distribution and abundance of key fish and wildlife resources could affect aboriginal lifestyles.

2.1.2 El Niño/La Niña

El Niño is a disturbance in the natural cycle of the ocean and atmosphere in which a warming occurs in the tropical sea surface waters of the eastern and central pacific ocean. This warming adds considerable amounts of heat and moisture to the earth's atmospheric circulation at the tropics resulting in large scale changes to the earth's atmospheric circulation particularly at the tropics and to a lesser extent elsewhere around the globe. This occurs every two to seven years. La Niña is the cooler phase counterpart to the ENSO and weather conditions are in general opposite to those occurring during El Niño.

Impacts on British Columbia from El Nino include milder air temperatures, warmer coastal waters, rises in sea level, and a reduction in snowfall. The effects on total precipitation (rain and snow) varies considerably across British Columbia.

2.1.3 Regional Climate Setting Summary

While climate change and ENSO provide challenges to meteorologists and the weather forecasting community, extensive and largely successful ongoing research efforts to study and better predict these phenomenon and their effects are occurring. In terms of effects on the region, while their significance cannot be downplayed, these issues are not believed to be problematic for offshore exploration activities.

2.1.4 Regional Seismic Activity

The Queen Charlotte transform fault zone extends northwestward from a ridge-trench-transform triple junction south of the Queen Charlotte Islands. The fault is further complicated by the

existence of three plate boundaries, the Queen Charlotte transform, the Cascadia subduction zone, and the Juan de Fuca Ridge, which meet in a triple junction offshore Vancouver Island. Although most of the potential volcanic activity would likely occur to the west of the Queen Charlotte Islands, effects of such activity could be experienced in the Hecate Straits where oil and gas potential exists. Although seismic activity has not changed in the last ten years, knowledge of plate tectonics and of the geology of the region has substantially increased.

2.2 BIOLOGICAL ENVIRONMENT

2.2.1 Ecosystems

The report and recommendations of the 1986 West Coast Offshore Exploration Environmental Assessment Panel describes the biophysical environment within the region of interest. The majority of this information remains valid in terms of overall ecosystems, species, and fisheries. Some changes have occurred, however, primarily related to species stocks and harvesting operations.

2.2.2 Finfish And Shellfish

The stocks of many species of fish have changed since the 1986 report. Species such as Sablefish Pacific Halibut, Petrale Sole, Rock sole, English Sole, and Pacific Cod have been declining as a result of declining recruitment and Pacific hake stocks have been declining since the late 1980's, returning to historic, typical levels. Rockfishes such as redstripe and redeye have increased over the past 15 years and Pacific herring are expected to remain stable or increase over the next few years as well.

Pacific invertebrate fisheries are diverse. Geoducks and intertidal clams have had quotas reduced since 1987 and the Pacific abalone fishery has been closed for most of the 1990's due to low stocks. Quotas for other species have increased (see Section 2.3).

Since 1986, steelhead have been re-classified as a Pacific salmon (*Oncorhynchus mykiss*), thus making six species of salmon caught by commercial, recreational, and aboriginal fishers in British Columbia. The other five are: Sockeye, Pink, Chum, Coho, and Chinook.

Sockeye and Pink salmon are the most abundant of the Pacific salmon species. Returns of Sockeye and Pink salmon have been at record high levels through the 1980's and the early part of the 1990's. However, more recently, returns have been highly variable due to extreme fluctuations in marine survival. For example, in 1995, returns of Fraser River Sockeye were well below predicted levels, even though the spawning escapement in the parent year was the highest ever recorded for this cycle.

Chum salmon catches in British Columbia appear to be highly variable and dependant on recruitment and environmental conditions.

Chinook and Coho salmon are highly valued by all fishers. However, marine survival rates for the 1990's have generally been low. Some runs of Chinook salmon, such as those along the west coast of Vancouver Island and some parts of the Strait of Georgia, have had severe conservation measures put in place due to protect low stock levels. Coho salmon stocks have also had low returns in the strait of Georgia and in the upper Skeena River watershed and management measures were taken in 1995 to reduce the harvest rates on Strait of Georgia

Coho stocks. Habitat degradation has also become a concern for Strait of Georgia Coho, as human populations expand and demand for residential, commercial and recreational development increases.

2.2.3 Seabirds

The Canadian Wildlife Service has conducted a comprehensive inventory of colonial nesting seabird populations in British Columbia since 1986 (Rodway et al. 1988) and an overview of the historical and current Information regarding seabird colony distributions and breeding populations has also been conducted (Rodway 1991). In general, over 5.6 million colonial birds are currently estimated to nest at 503 colony sites along the British Columbia coast (Rodway 1991). Most populations breed in high-density colonies which may contain various seabird species. In addition to the work being done by the Canadian Wildlife Service, the United States Fish and Wildlife Service (USFWS) has a seabird colony database and the United States Geographic Service (USGS) have a Pacific Seabird Monitoring database (Donna Dewhurst, USFWS, pers. comm). The Pacific Seabird Monitoring database includes colonies in British Columbia, however, at this time, it consists mostly of raw observations and is therefore not available to the public.

The following fifteen species of seabirds are known to breed on the coast of British Columbia:

Table 1 Seabird Species Found in British Columbia and their Distribution

SPECIES	DISTRIBUTION
Fork-tailed Storm Petrel (*Oceanodroma furcata*)	Numbers were estimated to be 380,000 in 1991. Colonies on the Storm Islands in Queen Charlotte Strait and on Gillam Islands on the west coast of Vancouver Island support approximately 49 percent of the total provincial population.
Leach's Storm Petrel (*Oceanodroma leucorhoa*)	Numbered over 1.1 million and bred in over 40 sites in 1991. A cluster of four colonies in Queen Charlotte Strait, plus two colonies on the west coast of Vancouver Island contain approximately 74 percent of the total population found an British Columbia's coast.
Double-crested Cormorant (*Phalacrocorax auritus*)	Generally confined to the Strait of Georgia where numbers have increased dramatically since they were first recorded. Estimates in 1991 gave a total of over 2,000 nesting pairs in the Strait of Georgia area.
Brandt's Cormorant (*Phalacrocorax pencillatus*)	Nesting in small numbers on Sea-lion Rocks off the mid-west coast of Vancouver Island, the maximum numbers recorded up to 1991 was 150 nesting pairs in 1970.
Pelagic Cormorant (*Phalacrocorax pelagicus*)	Although they breed along the entire coastline, most of the nesting population occurs in the south on the east and west sides of Vancouver Island. An estimated 4,495 pairs were breeding at 85 sites in 1991, with 52 percent of the population nesting in the Strait of Georgia and 26 percent along the west coast of Vancouver Island.

Glaucous-winged Gull (*Larus glaucenscens*)	These gulls have a similar distribution to that of pelagic cormorants. It was estimated that 28,953 pairs bred along the coast in 1991, with 48 percent of the total population nesting in the Strait of Georgia and 25 percent on the west coast of Vancouver Island. Data suggests that populations increased by as much as 30 percent in the Queen Charlotte Islands and by 48 percent along the northern mainland coast from 1975-1988.
Common Murre (*Uria aalge*)	Estimated at 8,640 birds which breed primarily at three sites. The colony at Triangle Island is thought to support 95 percent of the breeding population (4,100 pairs in 1989).
Thick-billed Murre (*Uria lomvia*),	Known to breed on Triangle Island which is the southern most known breeding site in the eastern Pacific.
Pigeon Guillemot (*Cepphus columba*)	The most ubiquitous breeding alcid in the province, nesting at an estimated 303 sites. A total of 9,345 birds were counted around colonies during the 1991 surveys.
Marbled Murrelet (*Brachyramphus marmoratus*)	Population estimates in British Columbia are unknown.
Ancient Murrelet (*Synthliboramphus antiquus*),	Generally known to breed exclusively on the Queen Charlotte Islands where estimates have been as high as 543,000 birds. These numbers were probably higher in the past as current trends in population numbers show declines and colony abandonments. In 1991, British Columbia supported approximately 74 percent of the world breeding population.
Cassin's Auklet (*Ptychoramphus aleuticus*),	The most abundant breeding species in British Columbia, their population is estimated to be over 2.7 million nesting at 60 sites. 73% of the population breed at 3 sites in the Scott Island and the rest breed in the Queen Charlotte I.
Rhinoceros Auklet (*Cerorhinca monocerata*)	Over 720,000 breed in British Columbia at over 30 sites. This represented approximately 56 percent of the world breeding population in 1991. Most are found on two colonies in Queen Charlotte Strait, four colones on the northern mainland coast and one colony in the Scott Islands
Tufted Puffin (*Fratercula cirrhata*)	Over 90 percent of the 78,000 breeding in British Columbia nest in the Scott Islands. Small numbers also breed throughout the coastline.
Horned Puffin (*Fratercula corniculata*)	Their summer range appear to be expanding along the west coast of North America. They have been confirmed nesting in British Columbia only at Anthony Island at the south end of the Queen Charlotte Islands

Source: Rodway 1991

2.2.4 Mammals

Research initiatives, such as the Coastal Ecosystems Research Foundation (CERF), have been conducting ongoing research on whales and dolphins in the Queen Charlotte Strait area. Relevant research includes Grey whale toxicology. Heavy metal and PCB levels in mysid shrimp populations, primary prey for grey whales, are being studied.

Grey whales are the first great whale to be removed from the endangered species list. As populations recover, more animals are returning to their historical British Columbia range to feed on mysid shrimp.

The Pacific white-sided dolphin is one of the most abundant cetaceans in the North Pacific, and in recent years, it has been sighted more frequently and in larger numbers in the inshore waters of British Columbia. Humpback whales have also been gradually returning to their original habitats, including Queen Charlotte Sound.

2.3 COMMERCIAL FISHERY

Between 1991 and 1996, the number of fish processing facilities on the Queen Charlotte Islands and the North Coast/Prince Rupert region has remained relatively stable showing some growth on the North Coast/Prince Rupert region. The Queen Charlotte Islands have averaged about two plants and occasionally a storage facility each year with the exception of 1992 when four plants were in operation. The North Coast/Prince Rupert region has increased its plant capacity from one in 1991 to seven in 1996 and its cold storage capacity from five to eight respectively for the same time period (British Columbia Statistics, 1998). These statistics, however, do not reflect the recent downturn in the fisheries for some species (see below).

Figures for product categories as a share of the total wholesale value of British Columbia seafood are only available for the years 1993-1996. During that time fresh sea food has increased from 32% of the market to 37% of the market and cured has increased from 22% to 26% for the same time period. However, frozen has dropped from 25% to 16% and canned has remained stable, dropping only 1% from 19% to 18% for that same time period.

2.3.1 Salmon

Landed catch by tonne for all species of salmon has continually decreased between 1986 and 1998. For the North Coast the catch has decreased from 52,677 tonnes in 1986 to 40,829 tonnes in 1991 to 27, 502 tonnes in 1996. Since that time the landed catch for all species of salmon has further decreased, but statistics are not yet available. Chinook have significantly decreased during the past ten years as have Coho, but the biggest decrease has been the Pink dropping from 27, 961 tonnes in 1986 to 22, 738 tonnes in 1991 to 8,128 tonnes in 1996. Chum dropped significantly between 1986 and 1991 (12, 618 tonnes and 4,282 tonnes, respectively), but have remained stable in the last five years. Sockeye are the only salmon species whose catch levels have increased (4,772, 7,832 tonnes and 12,358 tonnes, respectively). Landed value of the catch for all species on the North Coast is not available.

2.3.2 Herring

For the North Coast, the total herring catch by tonne including herring spawn on kelp increased from 1986 to 1991 (15,786 tonnes to 19,669 tonnes, respectfully), but dropped significantly in the intervening five years to 7,621 tonnes in 1996. The majority of herring is caught on the North Coast and the total value has continually increased despite the down turn. It has risen from $46,209,000 in 1986 to $58,273,000 in 1991 to $93,450,000 in 1996.

2.3.3 Halibut

The halibut catch by tonne has fluctuated only slightly on the North Coast over the past ten years. In 1996 the catch was only slightly below the 1986 level (3,503 tonnes and 3, 381 tonnes, respectfully). The majority of halibut is landed on the North Coast. Its value has increased from $18,765,000 in 1986 to $21,025 in 1991 to $32,699,000 in 1996.

2.3.4 Groundfish

Groundfish has taken a substantial beating on the North Coast, dropping from 21,187 tonnes in 1986 to 2, 749 tonnes in 1996 after rising to 33,669 tonnes in 1991.

In 1996 the majority of landings were sable fish and no landings were reported for flounder, hake, pacific cod, pollock, rockfish, sole and turbot. The value of Groundfish is not broken down by region.

2.3.5 Shellfish

Harvesting for several species of Pacific invertebrates have developed rapidly in recent years due to strong demand. Species such as Dungeness Crab and sea urchins (red and green) landings have increased dramatically. Dungeness Crab increases have been particularly high in the Queen Charlotte Islands and Hecate Strait area. Shellfish landings have significantly increased from 2,407 tonnes in 1986 to 8,454 tonnes in 1991 to 12,253 tonnes in 1996. In 1986 geoducks made up the bulk of the catch (1,693 tonnes). By 1991 sea urchins were the primary catch (5,497) and geoducks a distant second (1,278 tonnes). In 1996 sea urchins were still the primary catch (4,768), but closely followed by crabs (3,692 tonnes) and shrimp and prawns (2,439 tonnes). Only 987 geoducks were landed in 1996 due to the quotas being reduced (see Section 2.2.2). The value of shellfish is not broken down by region.

2.3.6 Sport Fishing

Sport fishing continues to be an important recreational activity for both residents and non-residents of British Columbia. However, the crisis in the commercial salmon fishery has affected the sport fishery so much so that sport fishery operators around the Prince Rupert area are reporting revenue declines averaging 30% from the last year of a productive salmon fishery (pers. comm D. Allen).

2.3.7 Aquaculture

Farmed salmon is the primary aquaculture species in British Columbia. Landed tonnes and value are not available from 1986 and aquaculture is not broken out by region, but since 1992 the landed tonnes and value have generally moved upward with only one year experiencing a down turn. In 1992, 19,814 tonnes of production from salmon aquaculture operations were worth $115,518,000. In 1993, this increased to 25,555 tonnes worth $138,143,000. In 1994 production had dropped back to 23,657 tonnes, but the value had increased to $153,815,864. By 1996 production had climbed back to 27,276 tonnes, worth $170,372,072. The value of farmed salmon is not broken by region (B.C. Statistics, 1998).

2.3.8 Native Food Fishery

The native food fishery still continues to be important source of food for the native people of British Columbia. Given the on-going rise in population on Indian Reserves and the cyclical nature of resource industry jobs, it can be extrapolated that the native food fishery will continue to be of importance and a major source of food.

2.4 OTHER RESOURCE USES

2.4.1 Tourism and Recreation

Protected areas in British Columbia have increased at more than twice the rate from 1992 to

1995 of any period since 1890. There are now 651 provincial parks, recreation areas and ecological reserves in British Columbia. The Regional District of Skeena-Queen Charlotte has 37. A marine protected area strategy is now being developed for the region. For northern British Columbia the tourism visitation rate has remained relatively stable over the past few years, with the exception of camping which was down 6 % between 1996 and 1997 (B.C. Statistics, 1998).

2.4.2 Sensitive Areas

Between Port Simpson and Bella Coola are numerous First Nations Reserves, Ecological Reserves, Parks and *Protected Areas*. *The First Nations Reserves* were all established more than ten years ago as were many of the parks. The Ecological Reserves are more recent. Listed below are the four types of sensitive areas by location.

Table 2 Sensitive Areas

LOCATION	FIRST NATIONS R.	ECOLOGICAL R.	PARK	PROPOSED PROTECTED AREA
HARTLEY BAY	1			
KITIMAT	3			
DOUGLAS CHANNEL	3			
KITLOPE			1	
FJORDLAND			1	
KLEMTU	1			
MOORE I.	1			2
DEWDNEY I.				1
BELLA BELLA	8		1	
DEAN CHANNEL	4		1	
BURKE CHANNEL	1			
SOUTH BENTNICK	1			
BELLA COOLA	1			
HAIDA GWAII	2	1	2	3
PORT SIMPSON	6	1	1	1
DUNDAS I.	8			ENTIRE AREA
NOB GROUP	1			
PRINCE RUPERT	3	1	2	
STEPHENS I.	1			3
KITKATLA	1			

PITT I.	9			
BANKS I.	3			
DOME HILL I.	1			
GIL I.	3			
COMPANIA I.				ENTIRE ISLAND
PRINCESS ROYAL	4	1		1

Source: Ecotrust Canada

2.4.3 Port and Shipping Activities

Prince Rupert continues to be the major shipping port for northern coastal British Columbia. However, as a result of external economic conditions such as the weakening of the Asian economy, the port and, subsequently, the city of approximately 17,000 have experienced an economic downturn. Prince Rupert was designed as a port to transfer natural resources from the interior of British Columbia to pacific rim and other markets, but these markets have dried up in the last year. The forestry sector is dependent on the Asian economy. Lumber cannot enter the U.S. market due to quota restrictions; a weakening of pulp prices have resulted in the major local industry, Skeena Cellulose postponing its capital $140 million expenditure program and it is losing approximately $3 million a month. The market for coal exports was primarily Asia, but shipments have significantly dropped off in the last year. The new grain handling facility is still operating, but at approximately 30% capacity. To add to the economic challenges of Prince Rupert, the fishing fleet has dropped from approximately 1000 to 400 over the last year as a result of the on-going salmon fishery crisis. The majority of employment in the fishing industry comes from processing of primary seafood products. For years approximately three times as many people were employed in the manufacturing sector as there were in harvesting the various species. This has helped to push unemployment rates beyond the 30% level. The negative publicity surrounding the salmon crisis has spilled over to the sport fishery with operators reporting revenue declines on average of about 30% The ferry service which brought substantial cargo and tourists into Prince Rupert stopped as a result of the dispute with the United States over salmon; the service has only recently resumed, but the cruise ship industry has disappeared (pers. comm, D. Allen).

2.5 PEOPLE

Four Regional Districts are located on or near the coastal areas affected by the moratorium: Central with no towns of significant population, but many Indian Reserves; Kitimat - Stikine consisting of the towns of Hazelton, Kitimat, New Hazelton, Stewart and Terrace; Mount Waddington consisting of the communities of Alert Bay, Port Alice, Port Hardy and Port McNeil and Skeena-Queen Charlotte consisting of the communities of Masset, Port Clements, Port Edward and Prince Rupert.

Of the four regions, Kitimat - Stikine has shown the greatest population growth increasing from a low of 41,121 in 1986 to a high of 46,046 in 1997, with the greatest growth occurring in Terrace (from 11, 433 to 12, 779 or about 12% increase between 1991 and

1996)and on the Indian Reserves (from 6140 to 7209 over the same five year period). The largest population decline occurred in the District Municipality of Stewart which lost 25% of its residents between 1991 and 1996 (from 1151 to 858 between 1991 and 1996). The Mount Waddington Region has fluctuated only a little in the last ten years with a high of 15,571 people in 1986 and a low of 14, 142 in 1992, but averaging approximately 14,600 throughout the ten years. However, 1997's population was reported at 15,246. The largest percentage increase (11%) between 1991 and 1996 occurred in Port McNeill (2641 to 2925) and the Indian Reserves (8.4%) from 1629 to 1766. However, with the recent decline in the fishery, the population may drop in the next few years. The population of Skeena-Queen Charlotte Region has slowly been increasing from a low in 1986 of 23,995 to a high of 25,724 in 1997. The largest percentage increase of almost 20% occurred in Port Clements (483 to 558) between 1991 and 1996. On the other hand, Masset experienced a 12.5% decrease in population from 1476 to 1293 for the same time period. Prince Rupert has remained relatively stable over the five year period at about 16,700. However, these figures do not reflect the recent downturn in the economy of that city. As can be observed from the above information, the population of the Indian Reserves is steadily increasing while the population of other communities rises and falls depending on the economic stability of the local resource industries (B. C. Statistics, 1998).

2.6 ADMINISTRATION

2.6.1 Local and Regional Governments

British Columbia has 28 Regional Districts, of which four are located near or adjacent to the moratorium area: Central Coast, Kitimat, - Stikine, Mount Waddington and Skeena - Queen Charlotte. The population of British Columbia is organized in the following manner: city, district municipality, subdivision of regional district, town, village, Indian government district, Indian Reserve and Indian Settlement.

2.6.2 Administration of Offshore Petroleum Resources

The British Columbia Ministry of Energy and Mines, Resource Development Division is responsible for setting policies related to oil and gas exploration and development. The Canadian Oil and Gas Lands Administration (COGLA) no longer exists. The National Energy Board has assumed the federal regulatory responsibilities formerly held by COGLA. In regions not covered by federal/provincial offshore Boards, the Frontier Lands Management Group of the Department of Natural Resources, under the provisions of the Canadian Petroleum Resources Act, is responsible for the call for bids and for the issuance of rights including licenses and administration. For offshore petroleum resources in areas where significant activity occurs such as Atlantic Canada, joint federal/provincial Boards (see Section 2.6.2.3) have on-going responsibilities. The provincial Environmental Assessment Act has responsibility for assessing offshore drilling activity. The federal environmental assessment process, through the Federal Environmental Assessment Act, can be triggered by a federal department such as the Department of Fisheries and Oceans. The process would be overseen by the Canadian Environmental Assessment Agency (CEAA). The provincial Department of Fisheries, Ministry of Environment, Lands and Parks also have marine related responsibilities.

2.6.2.1 Regulations

A list of appropriate regulations in Atlantic Canada are listed in Section 5.3.3.2. These types of regulations would be appropriate for coastal waters of British Columbia.

2.6.2.2 Exploration Agreements

Exploration agreements usually fall under the responsibility of an offshore Board.

2.6.2.3 Other Government Management Agencies " \l 4

Newfoundland

Petroleum rights are issued and administered in Newfoundland and Labrador by the Canada-Newfoundland Offshore Petroleum Board (C-NOPB). Established in 1985, this independent joint agency derives its powers from legislation known as the Atlantic Accord which was passed by the Government of Canada and the Province of Newfoundland and Labrador. The Board acts on behalf of both governments and consists of four members and a technical staff. The initial cost of setting up the agency was $1,137,625 in 1985 dollars, which was split 50/50 between the federal and provincial governments (1985 C-NOPB Annual Report). The C-NOPB later erected a building to store core samples at a cost of $1.5 million with annual administrative costs of approximately $35,000-40,000. Disputed decisions are handled through existing legislation, where applicable, or at the discretion of the Board (Pers. Comm. J. Fitzgerald). The Board's duty is to ensure that:

- X management of offshore land rights takes place in an orderly way;
- X assessments of the resource potential of the offshore area are completed in a timely basis;
- X offshore exploration and production activities are conducted in a safe and environmentally responsible manner;
- X exploitation of the resource is conducted in accordance with good oilfield practice to optimize recovery and avoid waste, and
- X operators' procurement decisions are consistent with their statutory obligations and agreements with governments to provide economic and social benefits to Canada, and in particular to Newfoundland (C-NOPB Annual Report, 1996-7)

Nova Scotia

In Nova Scotia, a similar Board exists. Established in 1990, the five member Board derives its powers from the Canada-Nova Scotia Offshore Petroleum Resources Accord Implementation Act S.C. 1988 c.28 (federal government) and the Canada-Nova Scotia Offshore Petroleum Resources Accord implementation (Nova Scotia) Act S.N..S. 1987 c.3. Similar to Newfoundland, the Board's responsibilities are the following:

- X enhancement of safe working conditions for offshore operations;
- X protection of the environment during offshore petroleum activities;
- X management and conservation of offshore petroleum resources;
- X ensuring compliance with the provisions of the Accord Acts that deal with Canada-Nova Scotia employment and industrial benefits;
- X rights issuance and management;
- X resource evaluation, and

X data collection, curation and distribution (C-NSOPB Annual Report, 1997).

Both Boards follow a similar procedure for managing the offshore. It consists of:

X Call for Nominations

Interested parties are provided with the opportunity to nominate crown reserve lands for inclusion in a Call for Bids. The C-NOPB has an annual rights issuance cycle; the C-NOPB has a semi-annual cycle.

X Plan for Interests

Both Boards submit plans for leasing of offshore petroleum rights for approval to their respective provincial and federal Ministers.

X Call for Bids

Upon receiving Ministerial Approval, both Boards initiate a Call for Bids for Exploration Licenses specifying the sole criterion for assessing bids. The criterion is either a cash bonus bid or a work expenditure bid. The cash bonus bid is the dollar value which a bidder will pay to acquire a particular license. The work expenditure bid is the sum of money a bidder commits to spend on exploration within the first period of the term of the Exploration Licence.

X Exploration License

Exploration licences are for a maximum term of nine (9) years, consisting of five (5) and four (4) consecutive years respectively. The licensee is required to drill or spud one exploratory well on or before the expiry date of the first period. Annual rentals apply to the second period.

X Significant Discovery Licence

If the drilling program results in a significant discovery and a Declaration of Significant Discovery is established by the C-NOPB or C-NSOPB, a licensee is entitled to a Significant Discovery Licence. This entitles the licensee to hold rights to a discovery area while the extent of that discovery is determined or until commercial development becomes viable.

X Production Licence

Once a commercial discovery is declared by either board, the licensee is entitled to a Production Licence subject to the approval of a development plan and a benefits plan. The Production Licence is issued for a period of twenty-five (25) years and for the duration of commercial production.

3.0 OFFSHORE PETROLEUM DEVELOPMENTS OF THE LAST TEN YEARS

3.1 THE CANADIAN OFFSHORE

3.1.1 Background

The Canadian offshore industry is almost forty years old, although the maturity of the industry has escalated over the last decade. The industry had its beginnings in 1958 on Canada's west coast in the Queen Charlotte Basin north of Vancouver Island when the first seismic program was conducted. On the east coast Mobil Oil Canada was issued its first offshore license in 1959 for the Sable Island block off Nova Scotia. However, it was not until 1966 that Mobil began conducting a seismic program followed by a drilling program in 1967. Meanwhile, Shell was beginning its drilling program on the west coast of Canada, but activity came to a standstill in the early 1970's with the imposition by the Government of Canada and the Province of British Columbia of a moratorium on all offshore oil and gas activities.

3.1.2 Nova Scotia

Unlike the North Sea, the maturation process for Canada's east coast offshore oil industry has been slower, enabling both government regulators and industry participants to more methodically regulate and develop the industry. The first significant oil and gas find occurred off the east coast of Canada in 1971 when Mobil Oil struck oil and gas at Sable E-48 off Nova Scotia. Following this discovery, the Cohasset field was discovered in 1973, but it was not until 1979 that the Venture field was drilled and declared to be of commercial potential. This signified Nova Scotia as a major offshore player and by 1982 legislation was in place to cover offshore oil and gas resource management and revenue sharing. This was updated in 1986, and in 1990 the Canada-Nova Scotia Offshore Petroleum Board was established to manage offshore petroleum resources on behalf of both the federal and provincial governments. In June 1992, production began on the Cohasset project and in 1996 fiscal negotiations began for the Sable Island natural gas project. In January 1998, construction began for the Sable Offshore Energy Project.

To date, Nova Scotia has declared over 20 offshore significant discoveries, two of which have been declared commercial. Gas and gas condensate are the primary finds with a total estimate of approximately 4.5 trillion cubic feet of natural gas and 126 million barrels of

natural gas liquids. Since 1967, one hundred and fifty-seven (157) wells have been spudded and companies have spent in excess of $4.5 billion on seismic and drilling wells as well as construction for the Sable and Cohasset Panuke commercial fields (pers. comm, A. d'Entremont, C-NSOPB).

3.1.3 Newfoundland

In Newfoundland, the first major oil discovery was recorded in 1979 when the *Glomar Atlantic* drilled the P-15 well on the Grand Banks' Hibernia field for Chevron Canada Resources Limited. After the Hibernia discovery, Chevron's controlling interest in this property was assumed by Mobil Oil Canada Ltd. In 1984 the second significant well was drilled by Petro-Canada in the Terra Nova field on the Grand Banks. During the early 1980's, exploration activity in Canadian frontier regions such as the Grand Banks was spurred on the National Energy Policy which provided incentive grants for drilling in remote waters. When the federal government changed in 1984 and the Progressive Conservatives ended the exploration grants, offshore activity came to a virtual standstill.

During the early 1980's, negotiations were on-going as to whom had jurisdictional rights over the oil and gas resources off the shores of Newfoundland and Labrador. In 1985 the Atlantic Accord was signed which recognized the Province of Newfoundland and Labrador as the principal beneficiary of these resources. This was immediately followed by the creation of the Canada-Newfoundland Offshore Petroleum Board. Once a jurisdictional decision was made, the oil industry began proceeding with development in confidence of a stable regulatory regime. Mobil and its partners submitted the Hibernia development plan in 1985 and began fiscal negotiations the following year. Oil and gas prices dropped significantly that year and development progress was slowed until prices recovered approximately five years later.

Construction of Hibernia's Gravity Base Platform began in 1990 and tow-out of the platform to the field occurred in June 1997. The much awaited production of the Hibernia field began in November 1997. While Hibernia was being readied for production, Petro-Canada began compliance procedures in 1995 for the development of the Terra Nova field, the second largest field discovered to date on the Grand Banks. In February 1998, most of their plans were in place in anticipation of first oil by year end 2000. Meanwhile, onshore-offshore drilling began on Newfoundland's west coast, but with no significant results announced to date.

Today, plans are proceeding for production of other significant offshore Newfoundland discoveries including the White Rose field by Husky Oil and the Hebron Ben-Nevis field by Mobil and partners. Because of the oil and gas promise of the Grand Banks as well as the cost efficiencies of sharing rigs and other equipment, Mobil, Chevron and Petro-Canada, long time players on the Grand Banks, have teamed with Norsk Hydro of Norway. They have formed the Jeanne d' Arc Basin Group to undertake a major exploration program in the Basin. Amoco has plans to drill on the West Bonne Bay block of the Grand Banks. Recent oil company announcements have included upcoming exploration on the Flemish Pass and Riverhead prospect.

Twenty-two significant oil and gas discoveries have been made in Newfoundland for a total estimate of approximately 1.6 billion barrels of oil, 4 trillion cubic feet of natural gas and 237 million barrels of natural gas liquids. Approximately 149 wells have been spudded and

companies have spent in excess of $ 9 billion dollars on seismic, drilling, and the construction of the Hibernia and Terra Nova production platforms (pers. comm., J. Fitzgerald, C-NOPB).

3.1.4 Georges Bank

As of 1998, two major offshore oil and gas regions are being developed in Atlantic Canada: south of Nova Scotia near Sable Island and offshore of Newfoundland's Grand Banks. A third region, off the west coast of Newfoundland, is under exploration. A fourth region, Georges Bank, is thought to hold potential, but no exploration drilling has taken place due to an oil and gas moratorium. A review of Georges Bank is important to the British Columbia study because both regions have a moratorium in place, are significant fishing regions and are environmentally sensitive.

Georges Bank is located in the Gulf of Maine. Approximately two-thirds of the Bank is located within the territorial waters of the United States while the other third is located within Canadian territorial waters. The Canadian portion of Georges Bank is part of the Scotian Basin. Because of depositional and structural history of its sediments, Georges Bank is thought by geologists to have hydrocarbon potential similar to that found in the Sable Island area. However, given its geological structures, its potential for gas and condensate is thought to be 1.06 billion barrels of oil and 5.315 trillion cubic feet of gas or the equivalent of four times more oil and gas than the Sable Island blocks.

The United States portion of Georges Bank is considered to contain limited potential as the ten holes drilled between 1976 and 1982 were dry. Scientists have proven that area to be a separate geological structure and, therefore, the United States exploratory results cannot be considered representative of the oil and gas potential of the Canadian portion of Georges Bank.

As a result of Texaco's interest in undertaking a drilling program on Georges Bank in 1984 and the subsequent negative responses to this program by the fishing industry and local communities, a moratorium was placed on petroleum exploration and drilling on the Canadian portion of the Bank in 1988 by the Canadian and Nova Scotian governments. A provision for review by a panel was established at that time with recommendations by the panel to be made to the appropriate federal and provincial Ministers by 1999. The Ministers would then make their decision as to whether the moratorium would or would not be lifted by January 1, 2000.

Historically, the Bank has been a prolific, rich and lucrative fishing ground for both United States and Canadian fishing interests. The most abundant fish species caught are scallops, ground fish and pelagic fish and lobster. Between 1976 and 1978 scallops accounted for 76% of the value of landings, finfish for 22 percent and lobster for 2 percent. Since that time the percentage of scallops caught has increased. The value of the raw product has varied between $67 million in 1978 to a low of $30 million in 1984 due to changes in scallop landings. This represents approximately 18 percent of the total value of landings by Nova Scotia fishermen. However, when processed, the Georges Bank catch, valued at approximately $64 million, is worth approximately $101 million. Processing, in general, adds approximately $37 million to the value of the catch. The relative importance of the George Bank fishery in terms of product value has remained consistent at between 12 and 17 percent of the provincial total for all but two years

between 1964 and 1984 (Gardner Pinfold, 1987).

During the past ten years of the drilling moratorium, the stocks, while variable, have not experienced the kind of collapse seen in other jurisdictions. Scallops stocks are similar to the late 1980's level, although they fluctuate yearly, and the stock is well managed. Haddock and yellow-tail flounder stocks are increasing, but cod is down about 25 percent from its 1988 level and still declining. The biggest change is in the reduction of fishermen on the Bank from approximately 2,200 in 1986 to 1,600 in 1996. This is partially a result of the increasing corporate presence in the fishery and changes in technological gear. Although there are fewer fishermen, the Bank is still a significant source of local employment (Griffths et al, 1998).

During the 1988 protests by the fishing industry and communities, a group known as "No Rig" was formed representing a majority of fishermen on the southwest coast of Nova Scotia as well as fish processors, community leaders and community groups. They were insistent in their demand that no offshore exploration occur that would jeopardize their fishing interests on Georges Bank. "No Rig 2000" has recently been formed, but some members of the original group are working in the offshore and others who were fisherman have found work elsewhere. At a recent series of public information workshops held in south west Nova Scotia by the Georges Bank Review Panel, only a fraction of people attended compared with the public meetings ten years ago and the negative opinions were neither as loud nor as strong as previously. Nonetheless, a number of issues were voiced (see Appendix B), but also some benefits (see Appendix B). The public hearings have yet to be held.

3.2 EUROPE

In both the North Sea and Canada's east coast, oil and gas exploration began about the same time. However, while Atlantic Canada took a long time to develop due to numerous factors, including jurisdictional disputes, environmental and technological considerations and the Canadian economy, exploration and development occurred at a rapid pace in the North Sea.

3.2.1 Norway

Norway 's oil and gas fields are found in three locations: the North Sea along the southwest coast of Norway, the Norwegian Sea above the 62nd parallel and along the northwest coast of Norway, and in the Barents Sea at the top of Norway's coast line. Oil and gas potential is equally split between the North and Norwegian Seas (40% and 40%) with the Barents Sea having the remaining 20%.

Norway's sovereignty over the Norwegian continental shelf regarding exploration for and production of oil and gas was proclaimed in May 1963. In the North Sea, the first licensing round was announced in April 1965 and the first well was drilled in 1966. In 1967 the Balder field was discovered followed by the Ekofisk discovery in 1970. North Sea oil production began in 1971 when the Ekofisk field came on stream. Oil was initially transported by tankers, but has been piped to the United Kingdom through the Norpipe system since 1975. Since then several major fields have been discovered and come into production, including the Frigg Field in 1971, the Statfjord field in 1974 and the Sleipner East and the Troll fields were approved for production in 1986.

In the Norwegian Sea, the first three production licenses were awarded in 1980. Since then several major fields have come into production. Fourteen of the 18 productions licenses awarded in the 15th offshore licensing round in 1996 lie in the Norwegian Sea.

In the Barents Sea a total of 35 production licenses have been awarded since 1980. A number of minor and medium sized gas structures have been discovered in this area. Recent studies conducted by operators demonstrate that it is technically feasible to develop gas fields in the Barents Sea. Water depths, difficult sea-bed conditions as well as the need for possible onshore terminals will require significant investments. To date, no commercial developments have taken place.

Beginning in the 1970's, a dedicated ministry, along with the Norwegian Petroleum Directorate, became responsible for administering petroleum activities. Foreign, multinational companies dominated exploration activities in Norway in the early years. Norway wanted those companies to establish a strong presence in the country in order to help build the country's reputation as centre for European oil and gas activity. However, Norway made it clear that it wanted to maintain control over all activities by creating Statoil and establishing the principle of 50 % state participation in each commercial field. Activity has steadily increased in Norway in the three seas. Up until early 1996 a total of 829 exploration wells had been completed or temporarily abandoned on the Norwegian continental shelf. Of those, 523 were wildcats and 306 were appraisals. Between 40-45 wildcat and appraisals wells are anticipated to be drilled each year depending on the Norwegian and world economy, the price of oil and other factors. Petroleum was discovered in 10 of the 21 wildcats drilled in 1995 which represents a good discovery rate. As of 1996, 35 fields were in production.

Oil production has steadily increased in Norway since 1981 and is expected to peak in the year 2000 and then begin to slightly decline. To counter an anticipated decline in oil production over the next decade, emphasis is being placed on finding new oil discoveries. Exploration has focused on finding resources near existing infrastructures and on testing new exploration models. Employment related to the offshore continually rose until 1993 when it peaked at just over 78,000, declining to 70,000 in 1995, the last year for which statistics are available. Of that amount 4 % were expatriates. Oil and gas represents approximately 13 % of the GDP (Royal Ministry of Industry and Energy, 1996).

3.2.2 United Kingdom

The major offshore oil and gas field are located to the north east of England between England and Norway in the North Sea. Much of the oil and gas is piped to both the Shetland and Orkney Islands. The first notable offshore discovery of oil was made on the United Kingdom's Continental Shelf in 1969 and the first oil was brought ashore from the Argyll field in 1975. In 1996 Britain was the world's 9th largest producer of oil and gas.

The government is responsible for awarding exploration licenses as well as approving all proposed wells and field development plans. Since 1964, 17 offshore licensing rounds have been held and by the end of 1996, 6,221 wells had been or were being drilled on the United Kingdom Continental Shelf. This includes 1,950 exploration wells, 1,171 appraisal wells and 3,100 development wells. At the end of March 1997, 173 offshore fields were in production with production starting at 16 new offshore oilfields during 1996-1997. In

1996 offshore oil and gas accounted for approximately 2.5 % of Britain's GDP. Approximately 30,00 people were employed during 1996, of whom 93 % were British nationals, and approximately 331,000 people were employed in support industries (Office of National Statistics, 1998).

Exploration is now taking place off the Faeroe Islands as well as in the Irish Sea.

4.0 PHYSICAL ENVIRONMENT

4.1 OBJECTIVES AND SECTION STRUCTURE

This section reviews physical environment issues as they may affect offshore oil and gas operations in the North Coast region of British Columbia. Included in this section are advancements in technology and forecasting as they relate to the physical environment.

4.2 DESIGN CRITERIA: NORMAL AND EXTREME ENVIRONMENTAL CONDITIONS

Definition of the normal and extreme environmental conditions likely to be encountered at a particular offshore location is a prerequisite for exploration and production operations. Generally this prerequisite can be met with sufficient meteorological and oceanographic (met-ocean) databases and appropriate application of marine dynamics, numerical and statistical modeling, laboratory tank testing, and other engineering principles.

4.2.1 Climate Normals

The Atmospheric Environment Service (AES) of Environment Canada has produced a CD of *Canadian Monthly Climate Data and 1961-1990 Normals, 1994 Release*. AES maintains an up-to-date database of all station parameters as well so that custom "normal" weather analysis by user-defined regions or for selected stations can also be readily performed. Parameters reported in the Normals include radiation, humidity, pressure, visibility and cloud, temperature, precipitation, and wind. In most instances over 30 years of observations are provided for coastal British Columbia. For example, Cape St. James has weather data recorded since 1925. The CD includes Canadian station data to 1993. The Normals provide reliable and representative descriptions of the physical environment in a given area.

Estimates of extreme wind and waves for the west coast were prepared in the early 1990's and include 100 year return maximum wave height and wind speed values (Swail et al., 1992) (Appendix C). These extreme estimates could be updated due to the advances in the west coast observational station, buoy network and improved database. The estimated extremes appear lower than some measured peak values in the Queen Charlotte Sound and a re-analysis of extremes for any design or operation considerations should be undertaken.

As reflected both in the 100 year estimates (Appendix C3) and in the measured maxima over the past ten years, extreme waves generally occur in the Queen Charlotte Sound and western end of Dixon Entrance, with extremes in the order of 2 to 8 m less in Hecate Strait, decreasing to the North.

Some observations regarding the state of ocean current research is presented in Section

4.2.2 Marine Dynamics Research

A wealth of experience and technological expertise exists worldwide in marine dynamics research which is necessary to support offshore oil and gas exploration. An example is the National Research Council of Canada's Institute for Marine Dynamics (IMD) in St. John's, Newfoundland. In operation since 1985, this world class facility has provided laboratory tank testing for the Grand Banks' Hibernia gravity based platform (GBS) and the Terra Nova floating production storage and offloading (FPSO) system, as well as numerous semi-submersibles, drill ships and platforms in operation in the North Sea, Gulf of Mexico, and elsewhere. Frequently, institutions such as IMD perform laboratory tests on drilling platforms destined for particular regions around the globe to ensure that proposed vessel modifications and vessel reactions/responses to the anticipated operating conditions of the region are acceptable. For possible new oceanographic areas such as British Columbia, this should be an engineering prerequisite.

While forecasters, oceanographers, and marine design engineers can benefit from additional information, the recent volume of existing data and knowledge should serve as an adequate base for any design criteria calculations. Engineering teams may still require specific field programs or met-ocean climatology studies to be completed before some construction, installation or operation activities are undertaken. Such work will serve to finalize or confirm their calculations.

4.3 ENVIRONMENTAL SUPPORT

The primary environmental support required for offshore operations is weather and sea state forecasting.

West Coast Marine Weather Forecasting

The state of marine forecasting for the west coast of British Columbia, particularly the north coast, has significantly improved since the mid to late 1980's. Specific improvements were sought at that time in the areas of storm event forecasting and advance warning time. The occurrence of a "marine bomb" event, or rapidly developing low pressure system, in October 1982 in which several fishing vessels were lost was a contributing factor to this need for improvement.

The Environment Canada weather office and forecast operations for the Pacific and Yukon regions are based in Vancouver. The west coast marine weather forecast areas presently served are illustrated in Appendix C, Figure 1 (URL http://www.weatheroffice.com/marine/west_coast_marine.html). A dedicated marine forecast desk, for both nearshore (coastal and 30-60 miles out) and offshore marine areas, has been in operation since 1985 and considerable experience has been accumulated since that time. The forecasting unit operates on a 24 hour, seven days a week basis, and issues wind and sea state forecasts every six hours which cover the subsequent 24 hours with an outlook for the following 24 hours. A sample marine forecast for Hecate Strait is listed below:

> GALE WARNING ISSUED.
> WINDS SOUTHERLY 15 TO 20 KNOTS RISING TO SOUTHEAST 25 TONIGHT AND TO
> SOUTHEAST 30 TO GALES 40 THURSDAY MORNING. CLOUDY WITH SHOWERS.
> SEAS ONE TO 2 METRES BUILDING TO 2 TO 3 METRES THURSDAY MORNING.
> OUTLOOK. STRONG TO GALE FORCE SOUTHEASTERLIES VEERING TO STRONG SOUTHERLIES.
>
> ---
>
> MARINE FORECASTS ISSUED BY THE PACIFIC WEATHER CENTRE OF ENVIRONMENT
> CANADA AT 10:30 AM PDT WEDNESDAY 9 SEPTEMBER 1998 FOR THE PERIOD ENDING 10:30 AM THURSDAY WITH AN OUTLOOK FOR THE FOLLOWING 24 HOURS.
> THE NEXT SCHEDULED FORECAST WILL BE ISSUED AT 4 PM PDT.

The marine forecast desk is primarily served by a network of marine weather reporting stations and buoys as illustrated in Figure 2 (URL http://www.weatheroffice.com/marine/north_coast.html). The stations report their parameters via satellite on an one hour basis, with observations being distributed to the AES observation network for application in numerical forecasts (see below) and as guidance information for the marine forecast desk.

The parameters measured and reported at the stations presented in Appendix C Figure 2 are summarized in Table 3.

Table 3 Marine Weather Observation Network Reporting Parameters

Met-Ocean Parameter	*Station Type*		
	Marine Weather Reporting Station	*Marine Weather Buoy*	*MAREP Station*
Air Temperature	T	T	T
Pressure	T	T	T
Visibility	T		
Wind Speed and Direction	T	T	T
Sky Cover/ Precipitation Conditions	T		
Wave Height		T	
Wave Period		T	
Sea Temperature		T	

Marine observations (e.g., wind and sea state) are also reported to the observation network by ships (ships of opportunity) traveling through the region. These observations are rarely continuous for more than a few days and the geographic areas that they cover along the coast are somewhat random. It is clearly advantageous to have these observations available, although they are of secondary importance.

Wind forecasts are prepared by Canadian Meteorological Centre (CMC) in Montreal (model MM5) using the network of observations and surface analysis charts. Surface winds are supplied to the numerical wave forecasting computer model WAM4 at CMC which is run twice a day and provides forecasts up to 48 hours. The WAM4 model uses a coarse grid with resolution on the order of 80 to 100 km. The CMC forecast information is used as guidance by the marine forecast desk to produce their own subjective forecasts. Typically, the marine forecaster will modify the CMC forecasts based upon the specific marine regions, the latest observations, and their wave forecasting experience.

In the early 1990's the forecast unit followed a "marine bomb" checklist to minimize the chance of these weather systems developing unnoticed. However, shortly after, the checklist was eliminated: the sophistication of the numerical forecast models and the increased experience of the forecasters made this task unnecessary. Weather system

information is now well managed and rarely does a storm go undetected.

Although no forecast verification system is active at present (i.e.,a system to check the validity of a forecast against the actual weather), recent verification of winds has been performed at stations, including Sartine Island northwest of Vancouver Island. The marine forecast unit indicates that it can adequately predict gale force and stronger events with a six hour or better notice time. Existing wave forecasts are believed to be accurate to within 0.5 to 1.0 m.

While atmospheric and sea spray icing are issues for the East Coast of Canada and exploration operations there, temperatures in the north coast region are generally not cold enough for this to be an issue. The waters of Hecate Strait, for example, are seldom colder than 8 degrees Celsius. As a general guideline water temperatures associated with freezing spray conditions are generally less than 5 degrees Celsius. Air temperatures must be colder than -2 degrees Celsius. Strong wind speeds and large wave heights are also contributing factors where freezing sea spray occurs.

Additional forecasting tools at the disposal of the marine forecasting desk include the Forecast Production Assistant (FPA). The FPA includes an embedded wave model and allows the forecaster to adjust surface pressures as input to the model to allow better wind forecasts and more accurate hindcasts for specific forecast areas of interest. Generally, this is a tool that would be applied for specific customers (e.g. offshore operators, or ships with specific vessel routing requirements) and is not used for the general public.

The marine forecast unit maintains good cooperative working relationships with the United States Weather Centre offices in Juneau, Alaska which results in shared information and mutual benefit to the forecast user communities along the British Columbia coast.

Recent consultations by AES with the user communities have indicated that users are satisfied with the marine forecasting service and no adverse comments have been received.

The network of marine buoys has provided additional data insights into the occurrence of extreme waves in the region. While not generally reported in the public network (e.g. www.weatheroffice.com), these buoys also record the maximum wave heights for AES. These observed peaks include values of 25 m and above off Cape St. James, and 30m near Delwood in the southern portion of Queen Charlotte Sound. These values are similar to the observed extreme wave in the region prior to the buoys, including the October 1968 maximum wave sighting of 30 m at the Sedco 135F east southeast of Cape St. James.

4.4 ENVIRONMENTAL EFFECTS

4.4.1 Environmental Response

Oil spill preparedness is an issue for all offshore operators. One of the earlier concerns and limitations about the north coast was lack of information about ocean and surface currents, in particular about the Queen Charlotte Islands.

4.4.1.1 North Coast Currents Summary

Between 1989 and 1995 the Canadian Hydrographic Service and the Ocean Science and Productivity Division of Fisheries and Oceans Canada, at the Institute of Ocean Sciences, undertook extensive observations of tides and currents in the waters around the Queen

Charlotte Islands, British Columbia. Analysis of these observations, and research into computer simulations of these currents continues into 1998. The project was funded by Fisheries and Oceans Canada and by the Panel for Energy Research and Development (PERD) of the Government of Canada. Findings of these studies are reported in the scientific literature (A list of publications is found in Appendix A).

The objective of this study was to improve prediction of oil spill trajectories in northern British Columbia waters. Numerical models of tidal currents and wind forced circulation were developed. As well, surface currents were investigated using Loran-C drifters, current meters, satellite imagery, atmospheric data and oceanic water property measurements.

In general, the state of water current research is good, particularly in open waters. Locations needing improvement include Prince Rupert Harbour and some of the inshore coastal river systems. Water current research during the winter could also be improved (pers. comm, Crawford).

4.4.1.2 Oil Spill Response

The Canadian Coast Guard of Fisheries and Oceans Canada retains overall responsibility for oil spill response under the *Canada Shipping Act*. The lead provincial agency for marine spill response is the B.C. Ministry of Environment, Lands and Parks.

The Canadian Coast Guard, Pacific Region, Environmental Response Branch maintains three Response Centres located at Coast Guard Bases in Victoria, Prince Rupert and Sea Island in Richmond. Each of these Response Centres maintains an Environmental Response Duty Officer 24 hours a day, 7 days a week. These Duty Officers are the first line of response to marine pollution incidents which occur within the Region. Their role is to ensure all reports of marine pollution are investigated and that an appropriate response is undertaken.

The Environmental Response Branch partners with government and industry to help meets its goal. Some examples within the Pacific Region are Environment Canada, the B.C. Ministry of Environment, Lands and Parks, the Vancouver Port Corporation and Burrard Clean Operations Ltd. (Coast Guard, 1998).

Under the *Canada Shipping Act* industries that transport or handle bulk oil are required to have a contractual arrangement with a Response Organization (RO). The only Coast Guard-certified RO in British Columbia is Burrard Clean Operations Ltd., a division of the Western Canada Marine Response Corporation. Burrard Clean Operations Ltd is certified to handle a 10,000 tonne spill and has response equipment in Esquimalt, Kitmat, Nanaimo and Port Alberni. As a contractor, Burrard Clean Operations Ltd has no command authority, but can provide operational response to an oil spill occurring anywhere along the BC Coast. A sister company of Burrard Clean Operations Ltd operates on Canada's East Coast. Eastern Canada Response Corporation is a certified RO operating in Atlantic Canada and Quebec, providing services to oil industry clients and others.

The use of remote sensing, such as Canada's RADARSAT satellite, for spill response, is an additional technological development whose research and application is ongoing.

4.4.1.3 Environmental Effects Monitoring (EEM)

The long-term monitoring of offshore oil development and operation on the east coast is a major part of the Environmental Assessment process. The role of monitoring is to identify potential sources of environmental effects, determine if implemented mitigative actions are effective, and to provide a foundation for sound adaptive management decisions (CEAA 1997). The emphasis of EEM programs is on the production phase of operations under routine conditions. In this context, monitoring is 'the study of long-term, chronic environmental effects associated with the discharge of such wastes as drilling muds and produced waters and with other disturbances' rather than effects associated with short-term or episodic events (exploration, blow outs and large oil spills). Compliance to all offshore regulations in terms of discharges are required for offshore oil and gas exploration. However, EEM programs have not been specifically required due to the short time-frame of these activities.

Companies wishing to conduct exploration work off the east coast must apply for registration and authorization from regulatory agencies such as the C-NOPB. These applications require that all activities be outlined, all potential environmental impacts be described, and mitigation techniques which will be utilized to minimize impacts of exploration activities be supplied. While EEM programs are not part of normal exploration activities, the general design on the east coast is outlined below.

General Design

EEM programs, in general, must be developed with sufficient precision and sensitivity to measure impacts. Worldwide monitoring experience has been reviewed by Continental Shelf Associates (1981); Institute of Offshore Engineering (1982); Shawmont Martec (1982); and Thomas et al. (1984). The majority of this previous experience concerning effects monitoring is from the Gulf of Mexico and the North Sea. The Panel Review of the Terra Nova Development (CEAA 1997) points out that many past EEM programs have been ineffective in preventing or detecting excess contamination. This appears to have been the result of a variety of causes including inadequate monitoring design, failure to identify and incorporate key environmental components, lack of standardization of measurement or problems with data quality, lack of statistical power, and an inability to isolate anthropogenic impacts from natural events or variation. The EEM programs designed for use off the east coast have incorporated past experience from other regions and improvements in these identified weaknesses. In addition, joint, or at least compatible, EEM programs are encouraged between oil and gas projects by regulatory authorities so that standardization and cumulative impacts can be monitored.

In general, biological monitoring in the North Atlantic and the North Sea has concentrated on the benthos rather than water column organisms (Mobil Oil 1985). The Hibernia EEM, which is currently active, has concentrated on benthic sampling of sediment and key sedentary indicator organisms to evaluate the long-term effects of its wastes which have been identified as having the potential to generate a negative impact, i.e., produced water, storage displacement water and oil-based mud cuttings. It has been generally agreed that the benthic environment, where contaminants may concentrate in the sediments and where the organisms are relatively sedentary, is a better source of useful indicators of environmental degradation than is the water column (Dicks 1982; Institute of Offshore Engineering 1982; Shawmont Martec 1982; Thomas 1984). The water column is a highly dynamic environment acting to disperse contaminants, and the physical, chemical, and biological components (plankton, eggs, larvae, etc.) are so variable that oil field induced-

effects cannot usually be separated from natural variations (Mobil Oil 1985).

4.4.2 Environmental Sensitivities

The federal and British Columbia governments jointly issued a discussion paper in 1998 regarding Marine Protected Areas for Canada's Pacific Coast. Such an initiative may impact future offshore activities. As well, additional environmental sensitivity information may need to be assembled, managed and maintained for particular coastal regions to assist in response decisions in the event of an oil spill. In recent years Geographic Information Systems (GIS) computer tools are often used in the creation of an environmental sensitivity atlas for a given coastal region. While time-consuming, if large geographic regions and/or many levels of environmental information are to be captured (e.g. shoreline makeup, wave energy, fisheries habitats, bird nesting locales, human logistics), a GIS is a useful tool which can save time and provide valuable input to critical response management decisions. Such a tool was recently created for the West Coast of Newfoundland (Dempsey et al., 1995) and was used in 1996 for producing environmental sensitivity maps for oil companies conducting exploratory drilling on the Port au Port Peninsula and in St. George's Bay. The environmental sensitivity atlas concept can also serve to complement or integrate with a marine protected areas program.

Environmental Support for Offshore Operations

For offshore oil and gas exploration and production, environmental operations support generally consists of a number of integrated services. These typically include:

- site and route weather (and sea state) forecasting;
- monitoring of the site meteorological and oceanographic conditions, (e.g. winds, temperatures, waves, currents);
- emergency response support (e.g. oil spill trajectory modeling, search and rescue), and appropriate means of communicating the information to shore (e.g. company and government regulators) and to marine and aviation operations personnel.

The implementations of these services generally include:

- suitable met-ocean measurement equipment on and near the offshore structure;
- trained weather observers to take and/or supplement automated data collection; and
- satellite, radio, and computer communications and database tools to enable timely flow of raw data and analyzed or forecast information.

The tools and technology used to deliver these services are in common use for offshore operations, including the North Sea and now on the Grand Banks and Sable Island on Canada's East Coast. In general, it is the level of environmental monitoring and reporting, nature of the forecast service (site/route/frequency/forecast content), and distribution network for the environmental information (i.e. who gets what, what kind of WAN or other infrastructure might be in place) required that will vary from location to location. Each operation typically has its own requirements which need to be addressed in terms of resources available and aspects of operation to support. It can also be expected that the regulator will have some additional requirements or guidelines for any offshore environmental program. While there is generally a period of requirements definition and analysis/design required for the provision of offshore environmental support services, the

knowledge base and technology available make the task a reasonably straightforward one.

4.5 SUMMARY OF ENVIRONMENTAL ISSUES

The marine environment is dynamic, and complex. Careful planning, in depth knowledge and state-of-the art equipment and technology are required by any offshore company conducting seismic, exploration, or production activities. Seismic and support vessels, helicopters, and offshore drilling platforms must be well designed for the range of conditions to be encountered. The crews and workers on these vessels must be aware of their operating environment, and adequately trained in their job functions and in all aspects of safety. Operators must also have an appropriate support network in place that includes marine forecasting, aviation flight following, environmental monitoring, and close working relationships with the federal (e.g., Environment Canada, Department of Fisheries and Oceans and the Canadian Coast Guard) and provincial (e.g., B.C. Ministry of Environment, Lands and Parks) authorities upon whose jurisdiction an operator's activities may impact.

These are prerequisites of any offshore activities. Legislation and government guidelines are also required to ensure that these prerequisites are met.

The National Energy Board has prepared *Guidelines Respecting Physical Environmental Programs During Drilling and Production Activities on Frontier Lands* (NEB, C-NOPB, C-NSOPB, 1994) to "clarify requirements for the operators of petroleum drilling and production installations concerning the observing, forecasting, and reporting of physical environmental data which appear ..." in the collective federal, Nova Scotia, and Newfoundland Frontier Lands Regulations. The guideline's primary objective is to ensure that appropriate met-ocean information is available during an exploratory drilling or production program to support the safe and prudent conduct of operations, emergency response, and spill counter measures. A similar set of guidelines should be implemented for British Columbia.

No major outstanding issues or information gaps exist in the understanding of the physical marine environment in the North Coast region of British Columbia to negatively affect offshore oil and gas exploration or related support activities beyond what has been noted in this report. The normal and extreme conditions of the environment are generally well-understood and quantified. The state of marine forecasting is without any obvious limitations or shortcomings. The infrastructure and technology to respond to routine environmental incidents are in place. There are ongoing technological advances in the areas of EEM and waste minimization. Furthermore, all operating companies must adhere to environmental assessment acts, marine protected areas initiatives, environmental guidelines, and other required legislation which are standard operating procedures for any major offshore operator.

Significant literature and data exists in the areas of wave, current, and forecasting research and technology (see Appendix A), as well considerable industry and government experience in these disciplines (e.g., Atmospheric Environment Service, Fisheries and Oceans Canada, Canadian Coast Guard).

5.0 ENGINEERING

5.1 OBJECTIVES AND STRUCTURE OF SECTION

The objective of this section is to review changes in engineering design and techniques employed in the development of an Offshore Production Asset (i.e. facilities, human capital, and resources) and to determine how those changes may affect any proposal to perform drilling activity offshore British Columbia. Offshore Asset Development consists of five stages: Seismic, Exploration, Development, Production and Abandonment. This section is intended to primarily focus on the first two of these activities. Section 5.3 outlines significant advancements in risk management, but these techniques are not regularly employed in the seismic and exploration phases. As these risk management techniques are of a significant nature and of fundamental importance in the development process, they are discussed in some detail in section 5.3.2.

5.2 SUBSEA DRILLING OPERATIONS

5.2.1 System Type

5.2.1.1 Seismic

The gathering of seismic survey data is more efficient than ten years ago, thereby providing more precise information about the likely presence and location of hydrocarbons. This, in turn, allows for a better selection of correct drilling systems and well design.

5.2.1.2 Exploration

Exploration drilling has improved (see Section 5.2.2), which allows for more efficient drilling operations in waters not previously considered to be economic for development. This, in turn, has led to improvements in:

- allowable water depths;
- the control of spillage;
- venting of hydrocarbons and environmentally unfriendly drilling fluids;
- the method of handling heavy loads and materials, and
- safety management of the drilling operation.

5.2.1.3 Development

Development of offshore fields includes drilling from submersible, semi-submersible and jack up drilling units as well as drill ships and semi-permanent structures designed to support process equipment in addition to the drilling equipment. For water depths in excess of 120 metres, submersible and jack up drilling units are not appropriate and for water depths generally below 1,000 metres drill ships are not economic. The favoured and generally utilised methods of development are from semi-submersibles and from semi-permanent structures. Semi- permanent structures include fixed platforms, tension leg platforms, compliant structures and converted, moored vessels (FPSO and other hybrid designs).

5.2.1.4 Production

General

During production, wells drilled by a semi-submersible are completed by a subsea Xmas tree (control valves, pressure gauges and chokes assembled at the top of a well to control the flow of oil and gas after the well has been drilled and completed) and tied back to subsea manifold structures and/or floating production equipment or to remote fixed structures. Wells drilled from a semi-permanent structure are completed by a surface Xmas tree and are accessible, during the life of the structure, by the drilling unit for subsequent work over.

Subsea

The application of subsea facilities for the development of satellite, marginal or deepwater hydrocarbon prospects has become widespread in all existing producing regions around the globe. Subsea production/water injection well numbers are approximately at the 1,000 level, with tie-back and control arrangements extending out up to more than 50 km. The field operators have adopted subsea facilities as a robust method for production or injection/re-injection, supported by international codes and standard, skilled contractors, experienced suppliers and other specialist service providers. Design, engineering, materials selection, and manufacturing and installation methods have been developed and optimised to result in high levels of reliability, availability, integrity and safety.
With the increasing use of deepwater fields {in the Gulf of Mexico, Brazil, Norway, West of Shetlands, Australia}, diver-less installation and intervention techniques have become established improving the economics and safety of these activities.

5.2.1.5 Decommissioning

Decommissioning of wells involves the removal of equipment to an acceptable level by authorities and making the well safe by means of plugging and abandoning. Abandonment of subsea facilities is anticipated to consist of purging, removal and return to shore of trees and housings, plugging the wells and cutting away of the casing to below seabed level. The pipeline and the umbilical would be de-commissioned and purged of hydrocarbons, the tie-in spools and jumpers removed and the remaining exposed ends buried to leave an un-obstructed seabed.

5.2.2Equipment and Technologies

Areas of change in the last ten years in drilling and their applicability to a drilling operation offshore British Columbia include the following:

•Semi-sub mersible drilling unit design has progressed with attention now being paid to layout of equipment in order to optimise the centre of gravity location and enable vessels to withstand storm conditions previously not possible.

XBlow out Preventer (BOP) stack design and utilisation. Semi-submersible drilling units utilise exclusively single subsea BOP stacks. BOP stacks are designed to include redundancy such that the minimum number of ram cavities would be 4 with certain operations requiring more. The build of BOPs follows stringent Quality Control procedures to maintain the integrity of material, weld and testing of equipment.

XMarine riser design for deeper waters can include emergency autoshear with the combined ability to shut the marine riser and prevent mud flow, during disconnection, into the sea.

XBOP systems now widely use multi-plexing as the method of control of the subsea equipment. Multi-plexing involves the use of hydraulic power to activate the equipment in question with selection and control of the operation electrically. This allows speedier response times for BOP operation and fewer hydraulic lines for running and connecting.

XSolids control and mud treatment has progressed to improve the recovery of useful drilling fluids and minimise the waste or potential disposal to the environment. Solids for disposal can be dumped to the seabed, recovered and treated for disposal to a dedicated well or recovered for disposal onshore.

XDrilling muds are now available with synthetic, non-toxic oil bases reducing the environmental impact of spillage of waste material.

XZero discharge drilling units are available where various degrees of containment can be specified from deck drainage to drilling fluid disposal to cooling water from engines.

XHandling methods have changed to incorporate restraining of loads with hydraulic, remote controlled arms leading to safer lifting operations principally in relation to tubular handling.

XDrilling equipment design, control and feedback has improved to the extent that drilling operations are statistically more successful with less time spent per well. The incorporation of Top Drive systems allows better control of the drilling operation and mud return monitoring enables early detection of well surge conditions.

XOperators and Drilling Contractors are generally expected to submit procedures to the authorities to qualify the operations to be performed and this will include safety and environmental issues.

XThe training of drilling crews is undertaken with a view to ensure safety and environmental issues are prioritised.

XRotating/vibrating equipment design has been developed to provide a quieter work and living space for rig crews. This has an additional beneficial effect on the environment by reducing the noise level. Noise output limits are applied and systems management is applied such that equipment is shut down when not required.

XRemote controlled TV cameras are widely used in both subsea and topside locations giving feedback and warning of extraordinary conditions.

XRedundant systems are widely in use allowing back up in the event of a malfunction.

XInteraction with Fishing Activities. Many subsea fields share the seabed with bottom-fishing activities. The increasing emphasis on avoidance of hazards {to both the facilities and to the fishing activities} has led to facilities that are "overtrawlable". This entails ensuring that fishing gear will not snag on {or under} or cause damage by the gear impacting on or being dragged over the protective housings, satellite installations or pipelines and umbilicals.

•Discharges into the Environment. Management of pipeline corrosion and controlling deposits/blockages due to waxes in the well fluids or hydrate formation often requires the injection of inhibitor chemicals into the subsea Xmas Trees or the pipeline. Some of these chemicals remain in the water separated in the host receiving facilities, but the re-injection of such produced water back into the reservoir is now becoming widespread as operators implement their "Zero Emissions" policies. Thus, chemical discharges are limited to seepage of bio-degradable control system operating fluids. Examples of this are the BP "ETAP" cluster of fields in the United Kingdom - North Sea and "Schiehallion" development in the North East Atlantic.

•Stability of Foun dations for Subsea Facilities. Support and protection structures and pipelines have been installed in areas of unstable or sliding seabed soils, with suitable driven or suction pile foundations (e.g., the Exxon Zinc field in the Gulf of Mexico). Thus, any local tendencies towards earthquake or seismic disturbances can be accommodated within the design.

•Ability to withstand severe downhole environments (e.g. high temperature/high pressure). High temperature integrated circuitry and ultrasonic downhole velocimeters to measure velocity from different points across the wellbore cross section are used to better control production process problems associated with high temperature areas. More and more drilling is taking place in such volatile environments, but the equipment is becoming more sophisticated and the associated costs are becoming lower.

5.2.3Issues and Significance

5.2.3.1 Routine Operations, Blowouts and Spills

Routine operations of significance to this environment are the following:

XThe loading and off loading of tubulars, drilling fluids, chemicals and equipment. There is a potential for spillage of materials and the correct selection of equipment and the following of proper procedures can mitigate this.

XThe disposal of waste drilling fluids. Waste drilling fluid disposal to the environment can

be eliminated by specifying zero discharge systems and by back loading materials to an onshore location.

XThe disposal of drilled materials. Drilled materials, specifically cuttings, can be ground to a paste and either injected to a disposal well or back loaded for disposal onshore.

Blowouts

Blowouts are infrequent but when occurring can be destructive and harmful in nature. Loss of life and massive harm to the environment can occur. This is minimised with the collection of comprehensive seismic data leading to the understanding of reservoir make up and the location of gas pockets. Correct well design and selection of drilling equipment and comprehensive training of the responsible drilling operators reduces the risk.

Spills

Spills have occurred but with the availability of Zero discharge drilling units, the possibility of disposing fluids to the sea is less likely. Liquid spills are automatically routed to a self-contained drainage system, which can be utilised to backlit material to an onshore location or injected to a disposal well.

Seismic Activity

Increasingly wells are being drilled in high temperature/high pressure areas, but technology advances and analysis of drilling units' performance after a seismic event are keeping pace with this type of drilling. Recently studies and analysis of this subject have been undertaken in Italy, Mexico and Norway.

5.2.3.2 Blowouts and Spills in Last Ten Years

Blowouts in a period from 1st January 1980 until November 1994 have been recorded as 205 (E & P Forum QRA Directory). Figures 4 and 5 show the incidences of blowouts per 1000 wells for both exploration and development well drilling with regression lines showing the average improvement over that period.

Worldwide Offshore Accident Databank (WOAD) Statistical Report 1996 quotes 11.36 Blowouts per 1,000 unit-year occurrences for Mobile units and 0.93 Blowouts per 1,000 unit-year occurrences for Fixed units during a similar period.

Spills during the period 1980 until 1995 were recorded by WOAD as 5.91 per 1,000 unit-year occurrences for Mobile units and 8.68 per 1,000 unit-year occurrences for Fixed units. The definition of a Spill/release being "Release of fluid or gas to the surroundings from unit's own equipment/vessels/tanks causing (potential) pollution and/or risk of explosion and/or fire".

5.2.4Information/Knowledge Gaps

Information available to the drilling contractor improves as more precise seismic data is collected, exploration well drilling continues and ultimately production from wells continues. The information gained from the earlier operations benefits the later operations and can lead to good well design and correct selection of drilling equipment and systems. This correct selection and design will lead to a safer and more environmentally friendly operation.

The areas for potential seismic and exploration drilling in British Columbia have not been specified to allow for a selection of other than semi-submersible drilling units. Greater knowledge of the areas of interest may allow for the selection of semi-permanent structures e.g., fixed platforms with less dependence on weather conditions. Alternatively, Extended Reach Drilling (ERD) may be selected with development drilling taking place from an onshore location.

5.2.5Lessons Learned

It has become possible to eliminate incidents where unacceptable materials enter the sea in all but the most severe incidents. The incident that cannot be eliminated, the Blow-out, can be mitigated against with the collection of early data, correct selection of equipment and system design and the comprehensive training of drilling operators.

5.3RISK MANAGEMENT

5.3.1 Definition

Risk Management is the process of decision making in order to maximise the chances of a positive outcome under conditions of uncertainty.

Risk can be defined several ways. It can be considered as capital staked under condition of uncertainty which would apply to the exploration phase, but a definition that relates to the development of an offshore industry would be the one cited in CAN/CSA-Q634-M91 which defines risk as "a measure of the probability and severity of an adverse effect to health, property or the environment".

5.3.2 New Approaches in last ten years

Accidents at Offshore Production Installations worldwide and, in particular, the July 6, 1988 explosion and fire on the Piper Alpha Platform with the subsequent loss of 167 lives in the U.K. sector of the North Sea, have emphasised the need for continued vigilance on the part of operators and regulatory agencies to ensure that offshore petroleum facilities are designed and operated safely. In the past, the typical approach to safety has been to add protective systems after the main elements of the process facility have been designed. It is now generally recognised that it is better to build in inherent safety during the conceptual and detailed design phase, and then provide protection to mitigate any residual risks.
It has also been noted that reliance on sound engineering practices, approved standards and codes of practice, certification and inspection regimes do not, in themselves,

comprehensively identify and highlight hazards and sequences of events that could lead to major accidents. The use of a holistic system of developing safety analysis techniques in a structured framework increases the likelihood that all hazards will be identified.

The major outcome of the Public Enquiry into the Piper Alpha disaster chaired by the Honourable Lord Cullen was the establishment of an Offshore Safety Case. Now, for each new installation, the following must be undertaken:

X a demonstration of the adequacy of the Operators Safety Management System;
X an assessment of hazards and risks to personnel;
X studies of safe refuges, evacuation, escape and rescue;
X demonstration of the adequacy of emergency control facilities, and
X fire and explosion analysis.

This approach to offshore safety has been given the term "goal setting". In both the United Kingdom and Norwegian sectors of the North Sea, legislation is being brought in to reflect the "new era". In Canada, the requirements of the Canada-Newfoundland Offshore Petroleum Board (C-NOPB) and the Canada-Nova Scotia Offshore Petroleum Board (C-NSOPB) also reflect the need for a safety plan containing the analysis referred to above.

As risk management is still a relatively young discipline, its potential as a decision making tool has only recently been recognised. Recent developments in the field have resulted in operators being better equipped to deal with risks. The main application of risk assessment during the last two decades has been concerned with identifying, analysing and judging risks associated with major hazards of a technical nature.

Quantified Risk Analysis (QRA) has become a specified component in the legislative requirements. The concept of QRA in association with Cost Benefit Analysis (CBA) has been further developed over the past several years to enable an operator to demonstrate that risk to personnel, the asset and the environment on an offshore facility have been reduced to 'As Low As Reasonably Practicable' (ALARP).

There are many ways in which operators can manage the risks they are facing. They can protect themselves from potential consequences or they can make provision against those consequences from occurring. Means of protection can be further sub divided into avoidance, prevention, control and mitigation. Making provision usually means ensuring against or carrying the risk. Of the risk management techniques noted above avoidance, prevention, control and mitigation are all effective in reducing risk to personnel, asset and the environment, while protection is merely a financing mechanism . The first four techniques must be used to 'design out' risk to achieve an ALARP design. The remaining or residual risks must be demonstrated to be ALARP.

The ALARP principle requires that risks which are below the determined intolerable level (typically a 1 in 1000 chance of death per year per individual) must be further reduced to levels that are ALARP. This is achieved through CBA where modifications or enhancements are considered for reducing levels of risk and must be implemented unless it can be shown that the cost of the modification or enhancement would be grossly disproportionate to the levels of benefit produced. Risks below a certain bound, normally taken to be 1 in 10^6 are deemed to be broadly acceptable and CBA need not be applied.

To simplify the concept, risk can only be considered as ALARP if the cost of further risk reduction measures can be shown to have a disproportionate cost to the benefit in risk reduction they achieve, e.g. an aircraft company developing a new airliner with only one engine would have a high probability of an incident of engine failure leading to a crash and the loss of the aircraft. The aircraft is, however, obviously capable of flying on one engine. If you were, therefore, to install an identical second engine, the risk of a single engine failure would still be the same but the risk of loss is reduced by the ability to fly on the second engine. Installing an identical third engine further reduces the risk of loss but the cost of installing the third engine with its fuel, maintenance and weight costs over the lifetime of the aircraft would potentially far outweigh the smaller benefit gained in risk reduction from two engines to three than the larger benefit from one to two engines. Given the value placed on the aircraft loss and the cost of the modifications, the CBA would be expected to demonstrate that the cost of the third engine would be grossly disproportionate to the benefit in risk reduction it gained. Therefore, the risk of loss through engine failure of the two engined option would be ALARP.

The use of ALARP is part of the planned change from prescriptive to goal setting legislation in which the goals of the regulator and the asset owner are now consistent, i.e., to reduce risks to as low as is reasonably practicable.

As can be seen from the above, considerable development in safety and risk management has occurred in the last decade from an owner and regulator perspective. However, it is noteworthy that these techniques are primarily used in the development and operation phase of a long term production facility. Risk management in the seismic and exploration phases is not regulated and is related more to the business risk of the owner as capital staked under condition of uncertainty.

5.3.3 Legislative Requirements

5.3.3.1 British Columbia

Due to the moratorium it would appear that British Columbia has no Offshore Specific Regulations in force at this time. However, significant environmental legislation and controls exist.

Prior to the existing moratorium, the British Columbia government established that a Pacific Accord would be in place before any drilling activity occurred. In fact, the Petroleum Resources Division within the Ministry had prepared draft regulations pertaining to offshore oil and gas activities. These were compatible with those used by the former Canadian Oil and Gas Lands Administration (COGLA) and other offshore regions in Canada. The draft regulations were not reviewed for this report as it was felt that their development would have been suspended by the moratorium. The regulations for other Canadian offshore areas

where development is currently taking place are reviewed below.

5.3.3.2 Atlantic Canada

Canada- Newfoundland Offshore Petroleum Board (C-NOPB)

As the authority having jurisdiction for the development of the Grand Banks oil and gas assets, the C-NOPB has been pushed to the forefront of the regulatory process with the development and production of the Hibernia field and the ongoing development of the Terra Nova field.

As a regulator under the Canada Newfoundland Atlantic Accord Implementation Act, the C-NOPB have published the following regulations:

- Newfoundland Offshore Petroleum Drilling (Newfoundland) Regulations (August 1992)
- Newfoundland Offshore Petroleum Drilling (Newfoundland) Regulations, amendment (February 1995)
- Newfoundland Offshore Certificate of Fitness Regulations (February 1995)
- Newfoundland Offshore Petroleum Installation Regulations (February 1995)
- Newfoundland Offshore Area Petroleum Production and Conservation Regulations (February 1995)
- Petroleum Occupational and Health Regulations - Offshore Newfoundland (November 1989) and in conjunction with the COGLA - Offshore Waste Treatment Guidelines (January 1989)

In the C-NOPB Prescriptive Installation Regulations, a requirement exists for a formal safety assessment. In addition, provision is made for a process known as a Regulatory Query Form which allows the operator to propose and submit a methodology other than that prescribed by the regulation. However, this methodology must demonstrate at least an equal level of safety. This flexibility in approach demonstrates an understanding by the C-NOPB Board that the existing prescriptive approach to safety may not fully meet the needs and that an alternative approach such as goal setting may be accepted as an alternative.

Canada- Nova Scotia Offshore Petroleum Board (C-NSOPB)

The C-NSOPB Regulations closely resemble the C-NOPB Regulations. As the authority having jurisdiction for the development of the Sable gas asset, it has introduced the following regulations:

- Nova Scotia Offshore Petroleum Drilling Regulations (November 1992)
- Nova Scotia Offshore Petroleum Drilling Regulations, amendment (May 1995)
- Nova Scotia Offshore Certificate of Fitness Regulations
- Nova Scotia Offshore Petroleum Installation Regulations

5.3.3.3 International

In both the United Kingdom and Norwegian sectors of the North Sea, the Health and Safety Executive (HSE) and the Norwegian Petroleum Directorate (NPD) are bringing forward regulations to support the goal setting approach to platform design.

The United States of America Minerals Management Service (MMS) have also acknowledged a move towards a similar goal setting regime.

5.3.3.4 Summary of Regulations

The only noted requirement for risk analysis or management within the regulations with respect to the exploration phase of a drilling program is found in the Certificate of Fitness Regulation (C-NOPB) 4 (3) (Issuance of Certificate of Fitness) that requires compliance with relevant components of the Installation Regulations. Installation Regulation 57 (13) (Ballast and Bilge systems) states "no floating platform shall be considered to comply with this section until the ballast and bilge system has been assessed through a Failure Modes and Effects Analysis (FMEA)".

There is no requirement for formal risk management or safety assessment techniques to be employed.

However, it should be noted that the Drilling Regulations are a very extensive prescriptive set of Regulations which have been developed from Federal Regulations. They employ the older "technology", as noted in paragraph one of 5.3.2 which is a typical approach to safety using protective systems after the main elements of the process facility have been designed.

On February 15th 1982 on the Grand Banks off the coast of Newfoundland, the semi-submersible drilling rig "Ocean Ranger" foundered and capsized with the loss of 84 lives. The prescriptive regulations of 1992 and 1995 are the mechanisms brought in that are intended to manage the risk to lives and the environment. These regulations are in ten parts:

Part I General
Part II Approvals to Drill
Part III Operational Requirements
Part IV Safety and Training of Personnel
Part V Operational Records and Reports
Part VI Well Evaluation
Part VII Well or Test Hole Termination
Part VIII Deposition of Samples from a Well
Part IX Final Well Reports
Part X Offences

and include but are not limited to requirements for:

- X design and construction to conduct operations safely and efficiently given due consideration to the operating environment;
- X Blow Out Prevention, well control and associated drilling systems;
- X safeguards against combustible gas accumulations, gas and fire and detection systems and alarms and fire fighting systems;
- X emergency electrical power;
- X contingency planning, safety and escape arrangements, rescue facilities and standby vessels and significantly in part IV, and

X requirements for safety and training of personnel, personnel protective clothing, drills etc.

In total 204 regulatory requirements are to be met, all of which have the general aim of safety for personnel, asset and environment. However, no matter how many regulations are in place, they are only as good as the regulator or a certifying authority, acting on behalf of the regulator, at enforcing them. Therefore, it is clear that there is a need for competent, knowledgeable regulators.

The exploration drilling program for any field is generally of short duration and involves the use of mobile "standard" equipment that has been in worldwide use for many years. Prescriptive regimes are far more able to cope with and regulate in this mobile market place, particularly with the different requirements for the varying territorial waters where semi-submersible drilling rigs may be used. Development of a production facility with a potential life span of 20+ years is far more costly and a technically more challenging exercise. Exposure to risk over a 20+ year period is far higher. Losses to life, production, the asset and environment can and are, therefore, evaluated using significantly different criteria and techniques. To date, minimal effort is spent on moving towards a goal setting regime in the exploration phase of the industry due to the mobile marketplace and the short term exposure to risk.

5.3.4 Issues and significance during seismic, exploration, development, production and decommissioning (blowouts, spills, transportation, natural hazards of the seabed

As previously noted all issues relating to the above subjects are covered by a prescriptive regulatory regime which is designed to ensure that the risk from these events is adequately mitigated. There is no requirement in the regulation for a risk management process.

5.3.5 Lessons Learned

Key lessons learned within the offshore industry are referred to in section 5.3.2. It highlights the development and implementation of a newer generation of non-prescriptive "goal setting" concepts for the development and production of offshore oil and gas assets. It understands the need for knowledgeable and competent people to fulfil the roles of organizations regulating the offshore industry.

5.3.6 Information/Knowledge Gaps

With respect to the Regulatory regimes, a significant gap exists between offshore Eastern and Western Canada due to the western moratorium. Significant measures have been taken in Eastern Canada to regulate exploration and development of significant oil and gas resources. These measures are designed to minimize risk for both humans and the environment. The British Columbia Petroleum Resources Division have indicated that they will solicit advice from other regulators if the moratorium is lifted.

6.0 BIOPHYSICAL

6.1 OBJECTIVES AND STRUCTURE OF SECTION

Oil and gas exploration and production have increased considerably in the past few years on Canada's east coast. Companies such as Amoco, Husky, Gulf Canada Inc., Hibernia

Management and Development Corporation, Mobil, Petro-Canada, and Pan Canadian have all undertaken exploration activities in offshore Newfoundland and Nova Scotia. In doing so, they have expanded considerably the knowledge of oil and gas exploration in terms of environmental management, contingency planning, potential effects, and environmental effects monitoring. This section reviews some of the advances made in the last ten years in oil and gas exploration, development, and production in Canada and what may be applied to offshore British Columbia. It should be stated here that the relative potential impacts of exploration as opposed to operations and production are low. The issues discussed in Section 6.3 are generally related to operation and production and, hence, can be treated as worst-case scenarios for exploration.

6.2 MANAGEMENT STRATEGIES OF THE LAST TEN YEARS

Companies engaging in oil and gas exploration on the east coast of Canada have incorporated environmental management strategies as part of their overall management framework. This has probably come about in part, due to requirements of increased environmental protection for production activities. The Terra Nova Alliance, for example, incorporates its environmental protection and occupational health and safety management within a larger system, the Total Loss Management (TLM) framework. TLM encompasses all programs and activities associated with health, safety, environmental, reliability, process hazard management, risk assessment and loss prevention. It identifies the elements and activities that must be incorporated into all operations to ensure that losses are minimized. It ensures that the environment is key in the decision making process.

As discussed in sections 2.6.2.3. and 5.3.3.2., the east coast also has petroleum boards which manage petroleum resources in offshore areas. The Canada-Newfoundland Offshore Petroleum Board (C-NOPB) is responsible pursuant to the Canada-Newfoundland Atlantic Accord Implementation Act (C-NAAIA) and the Canada-Newfoundland Atlantic Accord Implementation Newfoundland Act (C-NAAINA) (the Acts), for petroleum resource management in the Newfoundland offshore area. One of the functions of the C-NOPB is the dissemination of information relevant to its responsibilities. Petroleum boards also have the responsibility of regulating oil and gas exploration and production. Guidelines have been introduced to deal with most aspects of environmental protection. Some of these include: the Offshore Waste Treatment Guidelines (C-NOPB 1996a) Geophysical, Geological Environmental and Geotechnical Program Guidelines (C-NOPB 1996b), the Newfoundland Offshore area Guidelines for Drilling Equipment (C-NOPB 1993), and the Environmental Code of Practice for Treatment and Disposal of Waste Discharges from Offshore Oil and Gas Operations (Environment Canada 1990).

6.3 ISSUES DURING EXPLORATION/DEVELOPMENT/PRODUCTION

While the issues pertaining to exploration activities remain relatively unchanged since 1986, many advances have been made in environmental guidelines for exploration and production activities throughout the world. Many deal with specific operations such as geophysical operations (Environmental Guidelines for Worldwide Geophysical Operations 1992). Other relevant research has included the development of environmentally benign formate-based drilling and completion fluids (Downs et al. 1994) and the bio-treatment of exploration and production wastes (McMillen and Grey 1994). Environment Canada has recently published discussions on offshore and shoreline oil spill cleanup (Owens 1995; Environment Canada 1996b; Environment Canada 1996c).

6.3.1 The Fate and Effects of Marine Oil Spills

As stated in the 1986 report, the number of offshore blowouts from exploration have been few. The Terra Nova Development Environmental Impact Statement reviewed data on frequencies and severities of blowouts in the North Sea as part of their impact assessment (Petro-Canada 1995). The assessment noted that the numbers of major incidents involving released material in the North Sea have been remarkably few. It also stated that when drilling and production activities ceased, there was a rapid degradation of oil in areas of local contamination and the benthic communities showed signs of early recovery. The review panel stated that a note of caution is, however, appropriate as literature cited by the Terra Nova Alliance and other participants of the hearings also showed that it is unclear what the cumulative impacts on specific species and on the general ecosystem in the North Sea are as they are still inadequately and imperfectly understood.

However slight the chance of an blowout/spill event during oil and gas exploration, a brief review of the potential effects of marine oil spills on the environment is warranted. Environment Canada has published a recent discussion paper on the fate and effects of marine oil spills (Environment Canada 1996a). This discussion is similar to the fate and effects described in the 1986 report. However, some research has been conducted on various aspects of oil spill effects and the reduction of impacts. The following sub-sections are summaries of potential effects discussed by Environment Canada (1996) and reviews of the potential impacts associated with activities off the east coast, specifically the Terra Nova and Hibernia Developments. Since the Terra Nova and Hibernia Environmental Impact Statements relate to development and production rather than exploration, the potential impacts stated for these projects are probably higher than exploration activities would expect. This is due to the nature of operation facilities which are much more long-term, can involve large scale transport of product, and involve much more permanent structures and activities (in the order of decades). Therefore, the impacts noted for these projects should be considered as worst-case exploration scenarios.

6.3.1.1 Possible Effects on Birds

Marine birds are creatures which are most vulnerable to the effects of oiling, and are also one of the most visible. Birds can become oiled through direct contact with oil slicks in the offshore environment, or through contact with oil stranded in coastal environments where they nest or feed. The potential for impacts to seabirds of the Hibernia and Terra Nova offshore operations have been rated as negligible. This is due to the fact that these operations are not within a major migration corridor for passerine birds and many seabirds (gulls and terns) are more attracted to ships on the Grand Banks which not only provide a resting site but a potential food source as well.

Night-migrating birds have been known to be attracted to light sources during foggy or overcast conditions, and may collide with offshore structures (Avery et al. 1978). The drilling rigs and supply/standby ships of Hibernia carry and the Terra Nova Development will carry navigation and warning lights. In addition, working areas and helidecks will be illuminated with floodlights. The EIS of both projects state that there is little quantitative data describing the frequency of collisions, but anecdotal information suggests that they are rare. The small number of birds involved resulted in these collisions being deemed to have a negligible impact on bird populations. The potential of these impacts, however,

should be considered under local environmental conditions such as species using the area, nearby seabird colonies, migration flyways, etc.. In addition, monitoring programs should be implemented to document collisions so that information can be gathered.

Research is currently underway to try and reduce the potential interaction between an oil spill and seabirds. Bird deterrents have been developed to keep seabirds away from oil slicks. They can be deployed into a slink by helicopter and once activated, will emit a series of sudden, sharp sounds which can continuously deter seabirds within an 800 m radius of the device. They are also equipped with radio signal beacons for re-location and tracking.

6.3.1.2 Possible Effects on Pinnipeds

Pinnipeds (seals, sea lions, and walrus) are marine mammals which spend a great deal of time in the water and, therefore, can be exposed to oil as they forage for food. The effects on pinniped survival appear to be less a direct result of contact with a spill and more to do with the previous health of the animal before the incident. Mortalities appear to occur more frequently when naturally stressful circumstances such as poor feeding conditions, heavy ice, or moulting were prevalent before the spill. Hence, a spill appears to increase stress levels in animals. Marine mammal-oil encounters may also lead to indirect mortalities as the ability of female pinnipeds to recognize their young may be reduced and displacement of pinnipeds from known home ranges or habitats due to slicks may make them more susceptible to predation. Effects on pinnipeds noted in the Terra Nova and Hibernia assessments are principally related to noise generation which can apply to exploration activities as well (see Section 6.3.1.3). Sea-lion populations have been generally increasing on the west coast of North America and more consideration may be needed in these areas.

6.3.1.3 Possible Effects on Cetaceans

Cetaceans (whales, dolphins, and porpoises) come to the surface for relatively limited periods of time to breathe and, in some cases, to feed. During these brief periods, however, they may be subject to some potentially damaging effects from exposure to oil on the water surface. Death of cetaceans has not been documented as a result of oil spills, but whales trapped in oil-contaminated areas, such as enclosed bays, may be impacted. Animals already stressed by disease or other health problems are more likely to be adversely affected. Oil-cetacean interactions were considered negligible for both the Hibernia and Terra Nova Developments. Interactions with cetaceans and these projects was estimated to occur more as a result of noise.

Development activities of the Hibernia and Terra Nova Projects may produce intermittent low-frequency sounds. The Terra Nova EIS (Petro Canada, 1995) makes the following statements regarding the effects of noise on marine mammals, specifically whales.

> Specific information about the reactions of some baleen whales to low-frequency noise pulses has been obtained by observing their responses to pulses from airguns and other non-explosive methods of marine seismic exploration. Humpback, gray and bowhead whales all seem quite tolerant of noise pulses from marine seismic exploration (Malme et al. 1984, 1985, 1988; Richardson et al. 1986; Ljungblad

et al. 1988; Richardson and Malme 1993). The same may be true of fin and blue whales (Ljungblad et al. 1982; McDonald et al. 1993). These species usually continue their normal activities when exposed to pulses with peak received pressures as high as 150 to 160 dB (relative to I ΦPa), and sometimes even higher. Such levels are 50 to 60 dB or more above typical 1/3-octave ambient noise levels. However, subtle behavioural effects are suspected at least some of the time at lower received levels, at least in bowheads and possibly gray whales.

When exposed to sounds from a drillship, some beluga whales altered course to swim around the source, increased swimming speed, or reversed direction of travel (Stewart et al. 1982). Reactions to semi-submersible drillship noise were less severe than were reactions to motorboats with outboards. Dolphins and other toothed whales show considerable tolerance of drill rigs and their support vessels.

Bowhead whales did react to drillship noises within 4 to 8 km of a drillship when the received levels were 20 dB above ambient or about 118 dB (relative to I ΦPa) (Greene 1985, 1987a; Richardson et al. 1985a,c, 1990). Reaction was greater at the onset of the sound (Richardson et al. 1995). Thus, bowhead whales migrating in the Beaufort Sea avoided an area with a radius of 10 km around a drillship where received noise levels were 115 dB (relative to 1 ΦPa) (Richardson et al., 1990). Some individual whales are less responsive and may become habituated sufficiently to be seen within 4 to 8 km of a drillship (Richardson et al. 1985a,c, 1990).

Sound attenuates less rapidly in the shallow Beaufort Sea where these experiments were conducted than in temperate waters of greater depth. Off California, the reaction zone (120 dB (relative to 1 ΦPa)) around a semi-submersible drill rig was much less than I km for grey whales (Malme et al. 1983, 1984). Humpback whales showed no clear avoidance response to received drillship broadband noises of 116 dB (relative to 1ΦPa) (Malme et al. 1985). Baleen whales may show behavioural changes to received broadband drillship noises of 120 dB (relative to 1ΦPa) or greater. Broadband source levels produced by a working semi-submersible drilling rig may be about 154 dB (relative to 1 ΦPa) at I m. Assuming spherical spreading, received levels at 100 m distance would be about 114 dB (relative to 1 ΦPa). Thus, behavioural reactions could be limited to a very small area around the drilling rig.

Impacts of drilling operations on whales may be negligible to minor, sublocal, and short term for the Terra Nova Development. Although the effects of each well location would be short term, the effects of all drilling is considered long term since drilling in the fairly restricted field area will continue for 11 years or more. However, because the drilling activities will continue for several years, habituation may occur, thereby reducing impacts to negligible. Semi-submersible

drilling rigs are quieter than drill ships, and this technique will likely be used in the Terra Nova Field. Mitigation is not warranted because predicted impacts are small.

Exploration activities can be assumed to have noise associated with them, probably at a smaller scale, and hence should be considered. Also, the majority of the whales noted above are found in the Pacific Ocean.

6.3.1.4 Possible Effects on Fish

Spilled oil can exert toxic effects on fish and fish kills have been observed after major incidents, particularly when oil is spilled in bays or estuaries where it cannot be avoided by fish. Sub-lethal effects have also been noted such as the tainting of fish flesh as a result of exposure. Elevated concentrations of hydrocarbons in sea-water tend to be very short-lived with the highest levels found near the surface and bottom. In these areas, fish and eggs can be adversely affected. The eggs and larvae of groundfish such as cod which are present at or near the sea surface for several weeks, and species that feed at or near the bottom and rest near the sea floor such as halibut, would be particularly vulnerable to marine oil spills. Experience after major oil spills worldwide, however, suggests that these adverse effects are compensated for by recruitment from unaffected areas. EIS documents for offshore oil and gas operations along the east coast have stated that impacts to fish will be negligible and that possible positive effects may occur to some populations as a result of fishing closures around structures. Therefore, on fish populations, both the reef effect and the safety zone could have a positive, long-term, minor-to-moderate impact at the Terra Nova Development (Petro Canada 1995). Exploration activities would also have negligible impacts to fish, however, factors such as sensitive migration corridors, spawning grounds and feeding grounds should also be considered. On the west coast where exploration may be closer to shore than that on the east coast, consideration must be given to the large runs of Pacific Salmon which migrate along the coast as they head for British Columbia and Alaskan rivers.

Underwater noise caused by seismic exploration has been reviewed extensively by the Terra Nova EIS. The following are statements taken from that review.

> Seismic exploration with airguns can reduce the catch per unit effort in some fisheries and the abundance or availability of fish (Dalen and Raknes 1985; Dalen and Knutsen 1986; Skalski et al. 1992; Engas et al. 1993). Fish are not necessarily driven from the area by a loud sound, but they may sometimes change their behaviour and activity patterns.
>
> Chapman and Hawkins (1969) and Pearson et al. (1992) conducted experiments to determine the effects of strong noise pulses on fish. They used airguns with source levels of 220 to 223 dB (relative to 1 ΦPa). They noted startle responses at received levels of 200 to 205 dB (relative to 1 ΦPa), alarm responses at 177 to 199 dB, an overall threshold for the above behavioural response at about 180 dB, and an extrapolated threshold of about 161 dB for subtle changes in behaviour. In both tests, fish returned to pre-exposure behaviours within 20 to 60 minutes after exposure.

Noises emitted by a semi-submersible drilling rig are much lower in magnitude, but more continuous, than those discussed above. The fact that fish are well-known to be attracted to offshore drilling and production platforms indicates that fish adapt well to noises associated with offshore development activities. Impacts on fish of noise from the Terra Nova Development are stated as being negligible. Seismic operations would be used during exploration activities and hence should be considered.

For most wells drilled in recent years, low-toxicity oil-based drilling muds are used; discharges, if allowed, are closely monitored and controlled and concentrations of any oil released from cuttings are unlikely to be high enough to cause fish mortality. In the case of the Terra Nova field which is far offshore, Petro-Canada indicates that impacts on fish and the fishery from drilling muds would be negligible. Both the North Sea and Nova Scotia are moving to zero emission discharges and reinjection of solid fluids. This represents a significant positive advancement in protecting fish stocks from emissions.

6.3.1.5 Possible Effects on Invertebrates and Crustaceans

Benthic invertebrates (bivalve molluscs and polychaetes) are very susceptible to oil due to their immobile nature. Reduced growth rates have been observed on juvenile polychaetes and clams growing in oil contaminated sediments. In the long term, if oil exposure continues, bivalve molluscs can exhibit reductions in shell growth, tissue weight, nutrient storage and gonad development. Oil in bottom sediments have also been known to drive benthic invertebrates out of their burrows making them more susceptible to predation.

Death of benthic crustaceans such as crab, shrimp, and lobster have been observed after major oil spills. Sub-lethal effects exhibited in lab studies include premature release of eggs, reduced mating and reduced brood size. The success and timing of moulting in crustaceans has also been shown to be adversely affected by oil exposure. However, in the marine environment crustaceans are relatively mobile and may be able to leave contaminated areas. Therefore, the long term impact on these animals is expected to be low. In areas of the North Sea where extended (6-9 years) drilling has occurred, benthos on sediments initially contaminated with up to 4300 ppm of diesel-based mud from multiple wells, partially recovered one to two years after drilling (Mair et al. 1987; GESAMP 1993) and opportunistic species colonized substrates within a few months (Kingston 1992). North Sea data also indicate that biological effects and contamination from single wells may not last beyond one season of winter storms (GESAMP 1993). For the Terra Nova Development, low-toxicity oil-based drilling muds will be used, recovered and recycled. The 48-hour average concentration of oil released cuttings will be 15 g/100g dry cuttings which will meet criteria guidelines. Glycol-based muds will also be recovered and recycled but spent mud will be released at the site. The glycol that adheres to cuttings will quickly disperse within the water column. The components of water-based muds, which will also be used, are relatively non-toxic. The effects of the discharge of muds and cuttings are unlikely to persist beyond one storm season at the Terra Nova Development (Petro Canada 1995). This should also be true for exploration rigs which would generally be at a location for a relatively short duration.

The presence of structures can also modify the substrate characteristics of the adjacent seabed and infaunal community (Davis et al. 1982). Changes in benthic communities can also be related to increased predation by fish, such as cod, which are attracted to the

environment around structures, and by invertebrate predators, such as starfish, which are attracted to the area by the presence of fouling organisms (Davis et al. 1982). Scavengers are also attracted to the area by the presence of removed fouling organisms on the bottom (Dicks 1982). The Terra Nova EIS reviewed data on the effects of trawling on the benthic community and found that trawling has been shown in some studies to produce long-term changes in sediment characteristics and the structure of the benthic community (deGroot 1984). They have concluded that a safety zone around the structure may allow recovery of the benthos in the zone, and may also provide an indirect benefit in that another test area where comparative data for trawl effects studies could be available. Therefore, the effects of the Terra Nova Development on the benthic community are considered to be negligible. This again, would probably be true of exploration activities since drilling rigs would be located in areas for short time frames.

6.3.2 Environmental Assessment

The principal goal of environmental assessment is to obtain assurances that the repercussions upon the environment of proposed developments are identified and accessed in advance, and that requisite measures are adopted to limit them to acceptable levels. At this time, exploration activities on the east coast do not require an Environmental Impact Statement. They do, however, require registration and authorization from regulatory agencies. These applications require that all activities be outlined, all potential environmental impacts be described, and mitigation techniques be supplied which will be utilized to minimize impacts of exploration activities. Applications for exploration are unavailable, therefore, EIS documents for development and operation activities have been reviewed. These represent larger-scale activities and, hence, potentially larger-scale impacts. This should be kept in mind when reading the following section.

Recent developments in the Environmental Assessment Process (EIA) in Canada, and internationally, were presented at a policy forum in 1997 (CEAA 1997). The aims of the forum were: to review the current status of EIA in participating countries/organizations; to highlight trends, issues and directions of EIA; and to identify opportunities for further international collaboration. In Canada, recent key developments have been focussed on interpreting and operationalizing the *Canadian Environmental Assessment Act* (which deals with projects) and the *Cabinet Directive Policy and Programme Assessment*. Various regulatory, procedural training and research and development initiatives are being taken to support the implementation of the act and Directive. Key recent developments include:

- X Federal Coordination regulation to ensure federal EAs are efficiently coordinated among federal departments;
- X Procedures for an Assessment by a Review Panel were drafted in response to pressure from all sectors for greater effectiveness and efficiency which include specified timelines, increased notice time for hearing participants, and mandatory public meetings to discuss the adequacy of the Environmental Impact Statement;
- X a pilot project to explore the potential of non-legislated standards to improve the quality and efficiency of EAs;
- X the development of agreements with various provinces to ensure one EA process is used to meet the requirements of both jurisdictions;
- X the development of procedures and guidance on class screenings to encourage wider use within the federal government;

- X the development of training modules on implementation of the Act and the Cabinet Directive to encourage compliance for federal departments; and
- X the development of various guides for federal departments on specific aspects of the Act, i.e., follow-up programs, cumulative environmental effects, traditional ecological knowledge.

The most tangible improvement in EIS procedure is the increase in detail and experience involved in Environmental Effects Monitoring (EEM). EEM programs are formulated for long-term projects to measure predictions and forecasting made in an EIS at the start of a project. They also provide a means of ensuring compliance once a project begins and can also monitor such variables as cumulative effects. EEM programs outlined for various east coast projects are briefly reviewed below.

Environmental Impact Statements (EIS) for various projects off the east coast describe potential effects of all aspects of operations and provide worst-case potential impacts prior to mitigation. The Hibernia Development Project EIS defined various potential impacts to numerous environmental components such as marine plants, microbiota, zooplankton, fish and commercial shellfish, marine-related birds, marine mammals, and the ecosystem (Mobil Oil Canada 1985). Most impacts identified were summarized as negligible, minor, or no impact.

In general, the presence of the Hibernia operation facilities will have a minor impact on benthic organisms and pelagic fish which will be attracted to the structures for food and shelter. The biofouling community established on the structures, and the epibenthic and infaunal organisms and shellfish around the structures, will experience a minor impact from the liquid and solid releases associated with construction and development drilling. This impact will be associated primarily with smothering and burial. Water column and sediment microbiota may also experience minor impacts from liquid and solid releases due to the use of oil-base drilling fluids. Additive and repetitive impacts from construction and development drilling are rated as minor for the biofouling community, associated epibenthic and infaunal organisms, and shellfish. Minor additive and repetitive impacts may also occur on sediment and water column microbiota.

The Environmental Effects Monitoring (EEM) program which is underway at the Hibernia site has further reduced the potential, measurable impacts to two environmental components, that is, sediment quality and benthic fish species near the operations. To date, no changes in background levels have been detected. The Terra Nova Development EIS (Petro-Canada 1995) describes the effects of its production on fish, biofouling communities, and marine birds to be negligible as well. The Terra Nova EEM program has also proposed to look at the most likely measurable impacts. These are similar to those being monitored at Hibernia: sediment quality, benthic communities, and possible tainting of fish.

6.3.3 Cumulative Impacts

Cumulative impacts of any development have been receiving more attention than in past assessments. Cumulative impacts from developments occur when anthropogenically induced changes happen frequently in time and space so that the effects of an individual project cannot be assimilated, or when single projects interact synergistically to produce effects. Incremental changes, such as threshold events that establish new activities,

industries or practices are also typically considered as cumulative impacts. One particular effect of offshore petroleum developments that was noted in the Report of the Terra Nova Project Environmental Assessment Panel (1997) was the pre-emption of ocean areas from other uses such as marine protected areas.

6.4 LESSONS LEARNED

Significant lessons have been learned about the impacts of oil development in offshore areas. On March 24, 1989, the U.S. tankership Exxon Valdez, loaded with about 1,263,000 barrels of crude oil, grounded on Bligh Reef in Prince William Sound, near Valdez, Alaska. Approximately 258,000 barrels of cargo were spilled when eight cargo tanks ruptured, resulting in catastrophic damage to the environment. Damage to the vessel and lost oil was estimated at $3.4 million, but the cost of the cleanup of the spilled oil during 1989-1991 was about $2.1 billion. However, in the wake of this disaster much research has been conducted on the impacts of spills as remediation techniques. The spill prompted the environmental, scientific, and oil industry communities to increase their efforts to identify and understand the impact that major oil spills have on the world's waters and coastlines (World Information Systems 1990). For example, a coalition of six groups called for intensive research into the short-term and long-term environmental effects of oil spills. Numerous assessments and restoration plans have been published (Trustee Council 1991; National Transportation Safety Board 1990).

7.0 SOCIO-ECONOMIC

7.1 OBJECTIVES AND STRUCTURE OF THE SECTION

This Section briefly reviews the main phases of oil industry activity, some of the major socio-economic effects from these phases and their significance for local jurisdictions and communities. As well, several of the key new management strategies which have come into effect over the last ten years are outlined. The Section also briefly discusses a number of key issues that were brought up during the 1984 public meetings and outlines how these issues are dealt with in other jurisdictions. Interwoven throughout the material is information related to potential actions of governments and communities.

7.2 SCOPE

While the fundamentals of the offshore oil industry have not changed in the last ten years, there have been refinements in the way the industry works. This has included the introduction of new technologies (e.g., improved seismic capabilities, developments in directional drilling, further automation, and a move from fixed production platforms to floating systems and subsea completions) and new business approaches (e.g., a greater focus on 'core business' interests by oil companies, an associated increased reliance on contractors including use of alliances, and growth in the pooling or sharing of assets by different operators). There has also been a continued globalization of the industry, especially in the expansion of the contracting sector.

7.3 ISSUES AND SIGNIFICANCE OF THE FOUR MAIN PHASES OF OIL AND GAS ACTIVITY

7.3.1 Exploration

The first phase[1], exploration, consists of seismic and surveying exploration drilling which are critical in determining the existence of commercial petroleum reserves in licensed areas. (Seismic surveys may indicate that exploratory drilling is not justified, but companies may also commit to both seismic and drilling activity under the terms of an exploration permit.) Exploration is undertaken by a range of expensive and highly mobile seismic vessels, drilling rigs, supply/support vessels, helicopters and the like. These are owned and operated by specialist multinational companies which undertake exploration for oil companies on a contractual basis. Typically, onshore activity to support the offshore is concentrated at one shore base, airport/heliport and administrative centre, which may be at considerable distance from the concession blocks being explored.

As noted in the 1986 report (p.51), activity levels during the exploration phase are variable, with companies able to terminate their efforts for a variety of reasons including poor exploration results, better prospects elsewhere, a global recession in exploration or a local jurisdiction being 'unreasonable' in its requirements for local preference, taxation and/or environmental protection. This international mobility also makes it difficult to impose local employment, health or safety policies or for unions to organize oil industry workers.

Exploration commonly involves short-term, specialized work. A seismic program may last only a few weeks and use a crew of 20 to 30 individuals; a single well drilling program can be completed in three or four months using a rig with a crew of approximately 45 and two or three support vessels crewed by approximately 12 people each. As a result, limited opportunities exist for local involvement. For example, it is neither practical nor sensible to try developing local ownership of seismic, drilling or support equipment or to have locals become senior seismic or drilling crew if they are only in an area for a couple of weeks or months. The high levels of uncertainty in this phase means that the necessary investments of capital and time at the local level cannot be justified given the very short-term and/or periodic involvement with the industry. As a consequence, the community which serves as the shore base for exploration activity commonly sees workers and contractors from elsewhere, although they seldom remain in the community beyond the time needed to transit to or from the offshore or to do their business.

However, some of the work during this phase is a natural extension of tasks traditionally done by coastal peoples, such as stevedoring, marine crewing, ships-chandlering and ship-repair. Wharf space, heliports, storage yards, office space, hotel space and other existing onshore infrastructure are required, and these provide some opportunities for local employment and business involvement with only limited new training or investment required. Legislating higher levels of local involvement can be done, as was the case in Newfoundland during the late 1970s, but such workers will have to find employment internationally given a downturn in local exploration levels.

It should be noted that exploration activity is often accompanied by speculative activity on the part of local residents, especially early in the phase if there is, or is thought to be, a significant discovery. This may see local communities and business people wanting to

[1]It should be noted that while the phases follow in sequence for any field which comes into production, exploration normally continues in an area which has seen development, and most oil or gas producing areas continue to experience exploration, development, production and (periodically) wind-down in combination.

build industry infrastructure, e.g., support bases and office buildings, local residents buying or building new housing and municipalities rezoning land to permit such developments. These speculative responses are often based on a lack of understanding of the industry and its requirements and may be contrary to the interests of local residents and businesses, i.e. by producing house price inflation.

Recent developments in exploration which have socio-economic effects include:

- X improved three-dimensional and seismic technologies which have increased the success rate of exploratory drilling by more effectively identifying likely prospects. This results in more efficient drilling, thereby reducing the scale of activity and prospective local impacts, as well as reducing the time between the start of exploration and subsequent development activity (if any);

- X further globalization resulting in operators becoming more aware of the range of prospects worldwide and the requirements to become internationally competitive, in terms of both prospectivity and local exploration costs. This further limits the ability of provincial governments to impose local benefits and other requirements;

- X pooling of resources, with individual oil companies operating in a region sharing equipment and supply sources needed for exploration programs. This may limit local opportunities, in that oil companies will likely use a single shore base, office, heliport, etc. and share personnel and contractors. However, asset pooling may also make exploration more economically viable, in particular, by allowing shared costs for commissioning and operating exploration equipment, especially for activity distant from other oil patches. For example, a five-well drilling program in the remote Falkland Islands' waters could only be justified when a number of individual oil companies agreed to share equipment and support costs.

7.3.2 Development

This phase involves the design, construction and installation of production equipment, including systems to bring the oil and/or gas onshore. No guarantee exists that exploration will lead to development and production. Exploration may continue on and off for decades without a decision being made to develop a field. This was the case in Newfoundland, where exploration started in the mid-1960s, but the first development activity did not occur until 1990.

In the past, production equipment consisted primarily of steel or concrete platforms, containing drilling and processing facilities and associated accommodations, resting on the seabed. When located in deep waters or a harsh marine environment, these were often massive structures, expensive to build and difficult to tow to the field. As a consequence, they were constructed at coastal locations relatively near to the fields, such as Bull Arm, Newfoundland; Ardersier, Scotland or Stavanger, Norway. Such yards required a mix of specialist and non-specialist labour and had many of the characteristics common to any large construction project. This included a range of labour requirements and a limited project duration, resulting in the potential of 'boom-bust' problems. Any associated project design and administrative activity, commonly located in a capital city and/or near a major metropolitan area, was similarly variable in scale and of relatively short duration. However, the Hibernia construction project indicates how these problems may be mitigated and

prevented given the use of appropriate management tools.

Recent technological advances have limited the requirement for fixed, especially concrete, platforms and, hence, for these large scale construction projects. There is, instead, an increasing use of FPSOs (floating production, storage and off loading system) and other floating production systems. There has also been an increased use of tankers rather than pipelines to transport oil ashore, except in those areas which already have surplus pipeline capacity in place. Gas is still normally moved by pipeline. These changes have meant that:

- major production system components, which are easily transported, can be built at greater distances from a field (for example, the FPSO hull needed for Newfoundland's Terra Nova field is being built in South Korea). The prospective involvement of local jurisdictions in this phase of activity is correspondingly reduced and may be limited to local fabrication and support functions;

- however, given the jurisdictional capability and political will, oil companies can still be required to undertake locally significant design, fabrication and assembly work;

- the amount of work involved in offshore site preparation and installation may be significant and appropriate to local marine capabilities;

- reduced requirements may exist for pipeline construction projects and associated onshore processing and onward transportation projects. This can reduce the need to bring oil into environmentally vulnerable coastal areas, although cases exist, such as Newfoundland, where the product is brought to a transshipment terminal for transfer from shuttle to second-leg tankers.

7.3.3 Production

Production is potentially the most beneficial phase of activity to any jurisdiction. The main significance of the development decision is not the construction activity that follows, but the commitment it represents to ongoing activity in the area. Production from a large field may last several decades. The decision to develop one field greatly increases the probability that others will come into production, resulting in long-term employment and business opportunities. There is an increased likelihood that those directly employed will be local or, if hired from elsewhere, will live locally, increasing the multiplier benefits.[2] There is also an increased likelihood that the industry will wish to use local sources for supplies and services, and both workers and businesses will be willing to invest time and money in seeking these longer-term economic opportunities. The decision to develop a field also commonly represents a very significant fixed investment, making the company more amenable to local regulations and more sensitive to local concerns. Furthermore, production eventually leads to the local jurisdiction receiving resource revenues, although

[2] The 1986 report indicates that production phase shore base staff 'would generally be housed and supplied on a permanent basis at an accommodation facility at the shore base' (p.80). Such a system has never been used in North America, and there is no reason to expect it would be used in Northern British Columbia. Such workers will most likely live in, and include individuals hired from, communities within commute range of the shore base.

the nature and scale of this benefit will depend on such items as jurisdictional status and the fiscal regime.

Experience worldwide has shown that production generates large numbers of jobs in operations, maintenance and the periodic upgrading of systems. These are usually concentrated in a nearby urban area. However, changes in the industry over the last decade have had the following effects:

X given the use of floating production systems, production drilling is undertaken by floating rigs identical to, and owned by the same contracting companies as, those used in exploration;

X use of floating production systems and subsea completions, with lower capital and operating costs (including lower labour requirements), has increased the viability of smaller and relatively short-life fields; and

X resource pooling limits the total size of local opportunities and concentrates them in the hands of a limited number of companies.

7.3.4 Decommissioning

Decommissioning is of long-term concern, but it should be noted that the lifespan of individual fields and of production in any region is commonly underestimated, with new technologies extending the lives of the fields and the region and with new discoveries also extending the latter. The socio-economic effects of closing a field are of relatively short duration and present limited local employment and business opportunities. Indeed:

X difficulties experienced in decommissioning old structures, such as the Brent Spar, have led companies to design new structures with this in mind, further reducing the scale of wind-down activity and any associated positive or negative effects.

The closure of activity in a region is a composite of the sequential closure of a number of individual fields and, hence, a relatively long-term and gradual process.

7.3.5 Other

Oil spills and blow-outs can occur during all offshore phases, although the likelihood of either happening is remote. The socio-economic consequences of such an event follow from the biophysical impacts discussed in earlier sections of this report. An example is through losses of employment and business in fisheries or tourism. However, some short-term economic opportunities associated with clean up operations may exist.

7.4 NEW SOCIO-ECONOMIC MANAGEMENT STRATEGIES OF THE LAST TEN YEARS " \l 2

7.4.1 Control

Jurisdictions wishing to optimize the socio-economic effects of the oil industry need both a legal basis for control as well as economic leverage. The former can be the result of direct jurisdiction over the offshore, whether outright or in conjunction with a national government, or it can involve control over onshore infrastructure required by the industry. The Shetland Islands provide an example of the latter. With its control of harbours, the

local County Council exerts considerable influence over industry activity, but technological change is now lessening the industry's reliance on the nearest facilities and sites.

A legal basis for control can lead to proactive action (i.e., it can influence activity in order to optimize the impacts of actual activity, rather than just preventing activity), if there is also economic leverage. Such leverage requires that: the economic or strategic value of the resource is worthwhile for the industry to accept regulation; or in the case of federal PIP grants in the 1980s and federal support for the Hibernia project in the 1990s, government's assets are sufficient to subsidize industry activity. However, such subsidization is unlikely given both a continuing concern with deficit reduction and continued low oil prices.

7.4.2 The Objectives of Managing and Monitoring

Responses of coastal jurisdictions to an offshore oil industry have often been reactive. On the one hand, coastal jurisdictions may focus on limiting and/or preventing oil activity or mitigating its disruptive effects. On the other hand, they hope oil activity will have positive impacts on the economy either as a result of resource revenues or spin-off employment and business. Either way, the result is a passive 'coping with' offshore oil and its impacts.

The experience in Newfoundland and some other locales suggests a need for more proactive approaches and, in particular, more encouragement of local people to consider ways in which they want to manage the industry and its activity. The starting point should be 'what do we want?'; not 'how do we cope?'. This is a key consideration in addressing economic diversification and a number of other issues described on the following pages.

A greater emphasis on management and monitoring is necessary. A coastal jurisdiction needs to move from a regulatory regime which focuses on an environmental approvals process using often large and unfocused environmental assessments and move towards targeted assessments, a greater stress on socio-economic and environmental protection plans and other post-approval project management tools. This change also reflects an increasing acknowledgement of the high levels of uncertainty as to the scale of activity and impacts, especially during the exploration and development phases.

Effective and focused monitoring of activity and effects as they occur should be put in place. By providing critical and timely feedback about the positive and negative effects of a project, socio-economic monitoring provides governments, the community and/or industry with the information needed to respond quickly and appropriately to changes. In addition, the provision of feedback helps develop experience and expertise that can be applied to planning and managing future projects. As well, socio-economic monitoring can provide a mechanism for community participation in evaluating and managing the impact of a project. In developing such a system, it is critical to the usefulness of the information to take into account the objectives, indicators to be used, frequency with which data should be gathered, and the needs and expectations of the sponsors and other stakeholders. This will help in developing approaches and mechanisms which permit a rapid response to unanticipated or undesirable developments (Storey et al, 1991).

7.4.3 Balancing Revenues and Direct Benefits

A key interest of governments is the establishment of an appropriate balance between resource revenues and direct economic benefits. At one extreme, governments can use a laissez faire approach and seek to maximize the project economic rent and, hence, potential tax revenues. At the other extreme, they can impose local employment and business benefits requirements which create large-scale direct effects but reduce economic rent and, therefore, resource revenues. Most governments take a position between these extremes, based on such factors as their jurisdictional powers and economic and political priorities.

7.5 ISSUES

7.5.1 Regional Economic Development

As indicated in the 1986 report, exploration results in limited direct requirements for onshore infrastructure and facilities. There is a need for wharf space, heliports, storage yards, office space, hotel space and other infrastructure, but this is likely to result in the use of existing facilities in or around a single community. It is unlikely that exploration would involve significant new construction or the use of greenfield sites.
Development will likely require one or more fabrication or construction sites. These are associated with field development and related pipeline or transshipment infrastructure, but changes over the past decade (Section 7.4.1) have reduced demands for local facilities and have increased the likelihood of using existing facilities, e.g., a shipyard, located some distance from the field. Production expands exploration requirements and justifies further investment by the long-term nature of the activity. It may also involve the ongoing operation of any transshipment or pipeline landfall facility. It will require an expansion in management and administration activity, and associated office space requirements which most likely would be concentrated in a major metropolitan area and/or capital city. It should be noted that in all phases, an urban focus exists for offshore oil activity and infrastructure requirements.

The indirect land requirements of exploration, development and, to a lesser degree, production, are also small and concentrated in or around one or two communities. As is discussed below, exploration presents limited local employment and business opportunities and is unlikely to generate new urban development either though increased affluence or in-migration. The economic effects of the development phase will also be limited and relatively short-term and, hence, are unlikely to prompt new land development. The indirect effects of production will be concentrated around any transshipment or pipeline landfall, and in and around a major centre. However, given the increasingly capital intensive nature of the industry, such impacts will likely be modest in both absolute and relative terms, especially in metropolitan settings.

The socio-economic impacts of closing a field are of relatively short duration, while closure of activity in a region is a composite of the sequential closure of a number of individual fields and, therefore, a relatively long-term and gradual process. For this reason, the effects on coastal regions are gradual and plenty of opportunity exists to prepare for them. Most critically, this involves seeking to find alternative uses for, or decommissioning and restoring the sites of, oil and gas-related infrastructure.

7.5.2 Commercial Fisheries

None of the four environmental impact statements of Atlantic Canada oil and gas projects (Hibernia, Terra Nova, SOEP and Cohasset-Panuke) which received government approval to undertake drilling operations indicated that their proposed projects would have a lasting effect on fish populations. As pointed out in the Terra Nova Environmental Impact Statement (EIS), recent research indicates that anything adding to the relief or structural diversity of soft-bottom marine habitats will attract fish. Production structures, pipes, mounds of cement and debris also create artificial reefs that will attract fish. Pelagic fish are also attracted to structures but are generally found around and near structures. However, the fish community found within, very near and around offshore oil and gas structures, to some extent, depends on the nature of the structure. Studies conducted in the North Sea show that cod, haddock and other commercially important species are attracted to and concentrate around production facilities. On the assumption that there would be a safety zone surrounding any drilling unit, this would constitute a refuge for various fish populations. According the Terra Nova EIS, for structures projecting above the seabed a positive, minor, sublocal long-term impact on fish populations might occur due to the reef effect. Fish would be slightly protected from predation by bottom trawlers; on the other hand, a negligible to minor negative impact could occur on a ground fishery. The greater the number of exploration rigs, the larger the safety zone, which could create a short term negative effect on access to fishing grounds, but in the long term create a refuge and enhancement of local fish populations. This issue is more fully covered in Section 6.3.1.

7.5.3 Fisheries Compensation

During 1984 public meetings regarding proposed drilling offshore of the Queen Charlotte Islands, several issues regarding fisheries compensation were raised. As a result of these concerns, the Panel recommended in its 1986 report that a government compensation policy covering all stages of an exploration program be established prior to any exploration activity occurring. The Panel further recommended a series of compensation principles.

Many of the 1986 Panel recommendations are, in fact, now standard practice in other jurisdictions. However, some other approaches have proven to be more effective in actual practice. Any fisheries compensation policy must have input and buy in by the fishing and petroleum industries and, therefore, will need to be tailored to each fisheries region and petroleum project. Nonetheless, some general principles can be applied, particularly for exploration activity. An overview of fisheries compensation policies and trends is provided on the following pages.

7.5.3.1 Discussion

In dealing with any new oil and gas area, compensation is of major concern to fishing interests and needs to be addressed prior to drilling. However, oil and gas regions located in or near prolific fishing grounds have faced similar issues previously and the international offshore petroleum industry and the commercial fishing industry have co-existed for many years in other jurisdictions. Appropriate examples for this report are taken from Atlantic Canada and the North Sea.

The relationship between the international petroleum industry and the commercial fishing industry in the western context is based on the fundamental assumption that the two have the right to co-exist and that each will maximize its ability to facilitate that coexistence.

Neither party assumes that damage is inevitable and programs are implemented to prevent damage during normal operations and in the event of an accident.

The approaches used in the North Sea and in Atlantic Canada are very different, but with similar outcomes. In the North Sea, petroleum operations are mature with many operators and shared international jurisdictions. During the 1960's and 1970's compensation programs were developed in an ad hoc manner to address situations as they arose, but today well established programs are in place and accepted by both industries. In Atlantic Canada, a preventive approach has been developed with established contracts and protocols in place prior to any offshore activity. A majority of international offshore petroleum operators are familiar with and, in fact, insist on some sort of compensation program prior to undertaking exploration and production activities in well known fishing areas.

The basic objectives of any plan developed in the future, but based on today's practices, should include the following principles:

- X to develop a fisheries compensation program for fishermen and fishing enterprises which are directly affected by petroleum activities;
- X to create a compensation system which is simple, equitable and responsive;
- X to ensure that the program is based on consultation with the fishing industry, and
- X to ensure that compensation is directly received by these fishermen and fishing enterprises which are proven to be adversely affected by petroleum activities.

Generally, any compensation program is based on a set of basic assumptions specific to the region, but including some of the following:

- X damage is not inevitable;
- X based upon international experience, it is far more cost effective to implement a simple and practical voluntary compensation program prior to exploration and production activities than after these activities have taken place;
- X a compensation program is seen as successful if it is considered to have "teeth" and is rigorously implemented;
- X all proposed programs and approaches are developed in consultation with appropriate fishing interests including fishermen's associations, fish processing groups and government officials;
- X compensation can be addressed through the courts, but it is a long and costly process and, therefore, fishermen as well as fishing and petroleum companies prefer a voluntary system, and
- X the fishing industry should be no better nor no worse than prior to any incident.

In Atlantic Canada, prior to the development of any offshore oil and gas fields, a set of mutually acceptable principles or guidelines is established between the fishing industry and the petroleum company (s). These principles are expressed in commitments between the two groups as well as in specific programs which address the majority of concerns expressed in public meetings and include, but are not restricted to, the following areas:

- X anticipated or planned fisheries interference
  - platform loss of access program
  - offshore pipeline construction loss of access program

- offshore platform construction loss of access program

X unanticipated or accidental fisheries interference
- loss of access
- damage to fishing gear or vessels
- oil spills

It is important to note that only one blowout has occurred in Atlantic Canada in over 30 years of drilling. In 1984, the Uniacke G-72 gas blowout off Sable Island discharged approximately 1500 barrels of gas condensate, but it was not reported as an oil spill because gas condensate evaporates and dissipates usually within minutes of exposure to the environment. On the U.S. Outer Continental Shelf between 1971 and 1973 more than 22,000 wells were drilled and eight billion barrels of oil and condensate were produced, but only five blowouts occurred involving any discharge of oil and the total amount of that discharge was 1,000 barrels (Terra Nova EIS, 1997). Furthermore, an offshore well blowout involving a discharge of crude oil has never been experienced in Canada. Blowouts during drilling on a worldwide basis occur on a frequency basis of one spill per 26,000 wells drilled based on statistics from 1955 to 1988. The statistics during production and work over are not readily available because of lack of data, but it is estimated that the total oil produced offshore on a worldwide basis to the end of 1993 is about 100 billion barrels and only five very large spills have occurred during that time (Terra Nova, 1997). For more detailed statistics on blowouts, please refer to Appendix D.

While all compensation plans cover the possibility of blowouts, the majority of incidents are related to loss of access and gear replacement and it is those issues which are discussed in greater detail below.

7.5.3.2 Recent Trends in Compensation

Atlantic Canada

Most international petroleum companies now give high priority to environment, health and safety practices and take a management approach to issues regarding fisheries. In other words a planned proactive relationship occurs between the petroleum and fishing sectors in all matters regarding their interactions. In addition, the Canadian environmental assessment process, both the environmental and socio-economic, has become increasingly onerous and stringent resulting in increasing consultation between the two industries during the preparation stage of an EIS. Regulatory agencies stress these voluntary bilateral discussions as an effective way to identify and design appropriate mitigative measures.

Claimants may take action under existing legislation, such as the various Acts of Canada, or sue through a court of competent jurisdiction, but all petroleum companies operating on the east coast of Canada have developed their own fisheries loss or damage voluntary compensation programs as an alternative to actions through the courts.

All petroleum related projects which could affect the commercial fisheries, either through the exclusion of fishing activities or a reduction in fishing efficiency, have also made provision for loss-of-access or interference compensation, particularly during periods of intensive marine activity, such as exploratory drilling or during the construction of production facilities.

Of major concern to the 1986 British Columbia Panel was payment of non-attributable damage. In 1984 the Canadian Petroleum Association (now the Canadian Association of Petroleum Producers or CAPP) established a voluntary petroleum industry funded plan which allowed fishermen to claim compensation for damage sustained as a result of offshore exploration and production for activities where the party at fault could not be identified. Independent provincial boards were established to review and decide on cases. As exploration activity declined, the Boards ceased to function, but with the understanding that they would be re-activated when offshore exploration activity levels increased. Although this approach continues to reflect the industry's general philosophy, to date, no funds are in place to provide compensation should an unattributable damage incident occur.

The difference between the approach used on the east coast of Canada and the one suggested by the 1984 British Columbia Panel is that each production program differs and a blanket agreement will not suffice. However, in general, most industry damage programs developed by individual operators conform to the principles, guidelines and claims reporting and payment procedures articulated in the 1984 CAPP/CPA policy and discussed in the 1986 British Columbia Panel report. For exploratory drilling, the CAPP program, as discussed above, will most likely be followed in principle. The following table summarizes the fisheries compensation programs now in place in eastern Canada.

Table 4 East Coast Canada Industry Damage Compensation Programs

Project	Main Operator	Program Type	Coverage	Duration
Cohasset Panuke	Lasmo/Pan Canadian	gear and vessel	all marine areas	construction and production
Hibernia GBS	HMDC/NODECO	gear and vessel	construction areas	GBS construction
Hibernia GBS	HMDC	loss of access/ interference	construction areas	GBS construction
Hibernia offshore	HMDC	gear and vessel	platform area and marine traffic	production
Sable Gas	SOEP	gear and vessel	platform area, marine traffic, pipeline route, shore facilities	construction and operations
Sable Gas	SOEP	loss of access/ interference	shore facilities	construction
Sable Gas	SOEP	interference	actual economic loss	operations
Terra Nova	Petro-Canada	gear and vessel	platform area and marine traffic	production
Terra Nova	Petro-Canada	potential interference	under discussion	production
Nfld Transshipment Project	Nfld. Transshipment Ltd.	gear and vessel	shore facility and marine traffic	construction and operations

Nfld Transshipment Project	Nfld Transshipment Ltd.	temporary loss of access/ interference	shore facility area	construction
Bay St. George Seismic Survey	Talisman Energy	gear and vessel; interference	survey areas	survey
Port au Port Bay Seismic Survey	Hunt Oil	gear and vessel; interference	survey areas	survey

Source: AGRA Earth & Environmental, 1997

Norway

The Norwegian approach to compensation is discussed in less detail in this report because their situation differs substantially from the Canadian experience.

In Norway, over the past several decades, policies for the fishing industry have been developed within the framework of a highly organized and well articulated resource management regime. This policy approach is characterized by strong government/industry cooperation and dialogue and by a consensus based approach to the resolution of all matters related to the country's fishing industry. It also reflects a long history of public intervention in the economic and social development of Norway. The approach is based on a special committee of government established in 1980 whose report was submitted to government in 1985. However, its recommendations were not incorporated into relevant sections of the legislation governing petroleum activities until 1990.

In essence, the fishing industry is compensated for financial loss due to the occupation of fishing grounds by petroleum activities and facilities and for any damages to fishing gear and vessels associated with petroleum related debris and litter. Liability is addressed in a separate section of the overall Petroleum Act. No specific legislation exists in Norway for dealing with compensation for habitat loss, restoration or damage or for any impairment to marine resources resulting from petroleum activities. However, such matters are usually addressed in EIS's that petroleum companies are required to prepare. Where appropriate, relevant portions of these statements or environmental protection plans can become part of the operator's environmental assessment documents.

Administration of the compensation programs lies with the Norwegian Fisheries Directorate in Bergen. They are responsible for the establishment of the tribunals or boards which deal with such matters as occupation of fishing fields, pollution and waste damage, industry matters, appeals and non-oil damage claims. Claims involving damage have decreased substantially in recent years as the operators have become more regulated.

United Kingdom

In the United Kingdom sector of the North Sea, fishermen from the Shetland and Orkney Islands have been most affected by the oil and gas industry. Exploration and production activity escalated in the 1960's and 1970's without proper mechanisms for dealing with conflicts. Compared to Norway, the United Kingdom government has adopted a more "hands off " approach, and has been concerned with primarily two issues, loss of access and voluntary, industry funded, gear and vessel damage compensation programs.

Regarding loss of access, successive United Kingdom governments have not voiced any

support for the concept of loss of access compensation. However, the amount of money which the oil industry sets aside is now much larger than it was before the fishing industry made a loss of access case. In contrast, as early as 1975, the United Kingdom Offshore Operators Association established a voluntary damage fund to compensate fishermen who had suffered gear and vessel damages and financial loss as a result of incidents with petroleum related debris and litter which were numerous at that time. Although the voluntary damage fund has changed and evolved over the past twenty-five years, it continues to function as the primary source of gear and vessel damage compensation for fishermen operating in the UK sector of the North Sea. Initially, numerous claims were paid out, in part because the industry was not well regulated in these matters. In recent times, claims for either damaged gear or for loss of catch have been more common and claims for vessel damage are rare. On average, claims paid out annually for the last few years have been approximately $340,000. The number of claims has been decreasing, although the value has been increasing.

In conclusion, offshore fisheries compensation programs are normal practice in the western world. They have proven to be effective, impartial mechanisms accepted by the fishing and petroleum industries, are established prior to exploration, follow certain general principles and are agreed to by both industries prior to any offshore construction or production.

7.5.4 Education/Training

Education and training initiatives are recognized as a key component in any strategy to maximize local employment. However, they will only be effective if accompanied by local employment preference requirements.

The provision of education and training must match the employment considerations discussed earlier. That is to say, some limited opportunities exist related to exploration and development, but significant opportunities exist with production. Significant training can usually only be justified if it leads to longer term prospects with other projects, or if the skills can also be applied in other industrial sectors.

By way of example, the Hibernia construction project training largely met these criteria. This project involved initiatives to develop local capabilities in both the professions, especially engineering and construction trades. In the former case, training initiatives and benefit requirements led to over 1.8 million person-hours of design engineering work being undertaken in Newfoundland, mostly by local residents.

The primary resource for the construction trades training was the Cabot College (now the College of the North Atlantic), although other colleges were also involved on a competitive basis. Between 1991 and late 1995, a total of 55 training programs were offered. Upon completing their training, 1,844 of the male trainees and 65 of the female trainees obtained project employment. In total, 78 percent of the 2,463 persons trained found work at the Bull Arm site where construction of the Hibernia GBS was taking place. Using the securing of on-site employment as a measure of success, 67 percent of all courses achieved a success rate of 80 percent and above, and four had a 100 percent success level (Community Resource Services, 1996).

In addition to effectively providing access to employment on the Hibernia and subsequent Atlantic Canadian projects, some programs produced tradespeople with internationally

marketable skills. For example, tower cranes at the construction site were state-of-the-art and the 50 recently trained operators now have skills that are required on many major construction jobs. Some of the welding specialty trades employed on the project - such as flux core, submerged arc and titanium welding - were also transferable to other projects.

Development phase employment opportunities are generally short-term and shrinking in size, with the production phase presenting greater potential. The specific skill requirements for production are diverse (see above), with relatively small numbers needed in any particular speciality. Training requirements can largely be met by existing programs, especially given the long lead times available. However, training for some of the more specialized positions (e.g., offshore installation managers, reservoir and drilling engineers, loss prevention and safety personnel) is only available in a small number of centres, and there would be little justification in introducing local training for these specialities.

The Pacific Marine Training Institute, the engineering faculty at the University of British Columbia, the British Columbia Institute of Technology, the Technical University of British Columbia (now being established) and the technology programs at local colleges are well suited to provide the necessary education and training. In addition, research opportunities exist for many of the local institutes, universities and research related companies.

As discussed above, the socio-economic effects of closing a field are of relatively short duration, and the decline and ending of activity in a region is a composite of the sequential closure of a number of individual fields and, therefore, a relatively long-term and gradual process. Employment opportunities directly associated with wind-down and decommissioning are limited, as are the related training requirements. The same is the case with respect to oil-spills, with the training requirements primarily related to the need of being able to respond rapidly and effectively to a spill. These requirements are usually established by some combination of regulatory and industry standards.

The above discussion focuses on training issues related to employment opportunities in the oil industry itself. However, as is indicated in the 1986 report and reinforced by more recent experiences in frontier regions worldwide, it is also very important to provide civil servants, community leaders, labour leaders and the general public with a more general understanding of the industry, its prospective impacts, choices and options related to its management.

7.5.5 Employment

As has already been discussed, the 1986 report was correct in indicating that employment opportunities during exploration are limited and short-term (p.53). For example, between 1985 and 1995, a total of approximately 4000 person-years of exploration employment occurred in Newfoundland and Labrador and as has been described above, the variability in such opportunities, allied to the specialist nature of the more senior positions, mean that many exploration workers commute into the region on an international basis. Recent developments (see Section 7.4.1) have further diminished the numbers likely to be employed during this phase. Nonetheless, if the Industry grows, opportunities exist for a supply base, marine support, catering and yard service exist in towns such as Prince Rupert, which would result in significant local employment.

Many more jobs can be created during development. For example, the Hibernia project created about 21,000 person-years of employment in Atlantic Canada. However, there

can be a 'boom and bust' pattern to such employment and recent developments have reduced both the likelihood of large-scale construction projects in the region and the likely size of such projects. In the latter case, for example, it is estimated that the Sable Offshore Energy Project will only produce about 3000 person-years of employment in Atlantic Canada. Some of this employment is in traditional construction trades, but there is also likely to be a requirement for new specialists (see Section 7.5.4.3). Again, opportunities exist in the regions for the construction of portions of the production module and for supplying sub-trade services for those modules.

Lastly, for reasons discussed above, the greatest local employment opportunities are during production, although even these are smaller given the latest production systems and asset pooling. In Atlantic Canada, the Panuke-Cohasset and Hibernia fields employ an average of about 425 and 700 workers per annum respectively, of whom about 75 and 85 percent respectively are Atlantic Canadians. It is anticipated that the Sable and Terra Nova projects will employ an average of about 210 and 440 workers respectively per annum, again mostly drawn from the region. Given the long duration of production activity, the total amounts of employment involved are considerable. For example, it is estimated that Hibernia production will result in 13,300 person-years of employment, while Sable and Terra Nova will each generate about another 6000 person-years.[1] For reasons described above, this phase provides the highest levels of local involvement.

The specific employment opportunities associated with production facilities are in offshore production operations, marine and air support, and shore-based support and administration. These services could be located in towns such as Prince Rupert. By way of example, the state of the art Terra Nova floating production storage and off loading (FPSO) vessel will have 90 to 100 crew, half of whom will be working offshore at any time. Typical skill requirements will include deck officers, seamen, deckhands, maintenance personnel, mechanics, electricians, control room operators, loss prevention personnel, crane operators, catering personnel, radio operators, medics and environmental and forecasting specialists. Marine and air support will total 60 to 80 people and include the crew of supply and support vessels and helicopters. There will be 45 to 50 onshore personnel, including office staff, engineers, geologists, geophysicists, technicians, yard and dock workers, and marine operations specialists. (Petro-Canada, 1997)

There are also long-term employment opportunities associated with any pipeline or transshipment facilities, although these are increasingly automated. For example, the Newfoundland Transshipment Terminal, which will handle crude from the Hibernia, Terra Nova and probably subsequent fields, will only employ between 20 and 40 full-time or contract staff, including managers, equipment operators, electricians, maintenance personnel, dock workers and tug boat crew (Chevron, Mobil and Petro-Canada, 1996). Similar numbers are involved at pipeline landfall facilities.

The Newfoundland Ocean Industries Association has almost 400 member companies, most of which have a direct relationship to the offshore oil and gas industry. More than 250 oil related products and services are provided by these companies ranging from abrasives to wellhead equipment sales and services. All of these companies are located in Newfoundland and many started up, opened up branch offices or expanded as a result of the offshore.

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[1] It should be noted that field life estimates are usually conservative, and do not reflect the effects of new technologies in extending the lives of fields, and hence these are likely to be underestimates of total employment generation.

As previously discussed, the socio-economic impacts of closing a field are of relatively short duration and the employment opportunities directly associated with wind-down and decommissioning are limited. For this reason, the main employment-related challenge is trying to diversify the local economy.

Although a relatively remote occurrence, oil spills and blow-outs can happen during activity in all phases. Socio-economic consequences could happen that largely follow from the biophysical impacts discussed in earlier sections of this report, for instance through losses of fisheries or tourism employment. However, there may also be some short-term emplcyment opportunities associated with clean up operations.

There are clear opportunities to optimize the local share of employment levels in all phases. The 1986 Panel recommended that, as a condition of obtaining an Exploration Agreement, operators should be required to establish preferential policies for the employment of local residents. Similar requirements are standard practice in exploration and development agreements (the latter contain provisions relating to both the development and production phases) in Atlantic Canada and many other jurisdictions. They commonly include provisions related to hiring, employment monitoring, technology transfer and education and training. In Atlantic Canada, these are detailed in the Benefits Plan which project proponents must file with their Development Application (e.g., Canada-Newfoundland Offshore Petroleum Board, 1988). However, it has been argued that these provisions are not as effective as they might be and that there is a need for clearer strategic thinking in seeking to optimize regional economic benefits (Newfoundland Ocean Industries Association et al, 1998).

7.5.6 Business Opportunities, Industrial Development and Infrastructure

As is the case with employment, business opportunities associated with exploration are limited and uncertain; those related to production are considerable and long-term. While development opportunities can be considerable (as in the case of Hibernia), they are generally and increasingly short-term.

This is not to say that exploration expenditures are not considerable, or that some companies may not have successful involvements with exploration. In the former case, it has been estimated that the oil industry spent nearly $8 billion on exploration in Atlantic Canada between 1967 and 1987. However, the majority of this was spent on geological, geophysical and drilling activities undertaken by large multinational contracting companies (as an indication of the costs involved, the current day rate for a newer semi-submersible drilling rig is about $125,000). In terms of local participation, the main opportunities for local companies are with harbour, warehouse, office, apartment/condominium and hotel facilities or in the provision of environmental, catering, transportation, professional and other services. These businesses can be located in towns such as Prince Rupert. However, given uncertain levels of activity, it would be a mistake for such companies to develop too great a reliance on the oil industry.

The possible business benefits of development phase activity are demonstrated by the Hibernia project, outlined below. However, it must again be cautioned that the likelihood is small of the occurrence of further such large-scale and relatively long-term (seven year) development projects.

Total development phase expenditures on the Hibernia project were about $5.8 billion, of which about $2.7 billion went to Atlantic Canadians. Case studies of Hibernia related companies indicate the size and range of potential benefits from construction projects. Most evident was an increase in business activities. For example, the Marystown Shipyard did $120 million Hibernia-related work over a two year period, while at a much smaller scale, a local service station, which became involved in construction site electrical installation and repairs, realized $2 to $2.5 million of business from the project. In a three year period a St. John's-based automobile dealership sold almost 400 vehicles worth $7.4 million to project companies, and conducted approximately $70,000 per month in parts business at the construction site.

In several cases, Hibernia activity allowed additional hiring and technological upgrading. In the case of one engineering consulting company, an additional 70 positions were created, mostly at a high professional/technical level. At an engineering and architectural supplies and services company in St. John's, four of the fourteen full-time positions were the result of project business, while over a four-year period all hiring at another engineering and construction services company, was a direct result of the project. Memorial University of Newfoundland was the beneficiary of several oil related research chairs and the Marine Institute of Memorial University, as well as several marine related institutions, signed research and training contracts with the oil companies.

Hibernia did more than simply create work; it also increased companies' capabilities and competitiveness. For example, it contributed to company modernization. The level of upgrading varies from the installation of a fully computerized accounting system at a service station to a $42 million expansion project at the Marystown Shipyard. Through the Offshore Development Fund, the University received substantial funds for upgrading its marine and offshore related expertise and facilities.

Companies experienced other, less tangible, benefits which have contributed to longer-term success. Experience with Hibernia and other oil projects increased their understanding of the industry's technology, language and requirements, and dealings with oil companies and their contractors resulted in the acquisition of experience and expertise which is transferable to other business opportunities. For example, they gained experience with joint-venture arrangements, complex bids, document preparation and project management. Many companies also adjusted their operations in order to meet the quality standards expected by the oil industry, and this led to internal attitudinal changes with a higher priority given to quality and client satisfaction.

Overall, work on offshore oil projects, aided by the local benefits provisions, generally expanded and diversified Newfoundland business and research capabilities, with local companies, universities and research institutes building on their oil-related experience and expertise to sell to the industry elsewhere. Their new expertise and experience made them more competitive and fostered a greater confidence in their capabilities, not only within the local context but on a global scale. The connections and contacts developed through various projects provided local companies with exposure to international opportunities and have broken them out of the local-operations mind-set.

Many companies and research institutes have realized that they can compete on the international level and have adopted an aggressive marketing strategy to pursue overseas contracts. The effect of oil-related work on local companies' bidding, management, quality assurance and control and other business capabilities has made them more competitive in

local, national and international markets, both with respect to oil and non-oil work. In these regards, involvement in development phase activity has helped companies prepare for opportunities in the production phase.

However, as has been noted, construction projects like Hibernia are becoming rare. The Sable and Terra Nova development expenditures will each be about a third the size of those for Hibernia, with the total Atlantic Canadian share of expenditures being about $500 million. This compares with estimated total production phase expenditures of $8.3 billion for Hibernia, $2.5 billion for Terra Nova and $2.0 billion for Sable. And such longer-term expenditures will result in a much greater share of expenditures being captured by local businesses[2]

As previously discussed, the socio-economic impacts of closing a field are of relatively short duration and the business opportunities directly associated with wind-down and decommissioning are limited. For this reason, the main business-related concern is seeking to diversify the local economy.

7.5.7 Investment

As has been discussed previously, little local investment should occur at the exploration stage until some indication of a commercial find is determined. Exploration can be used for learning curve experience, but with caution. Production is the phase which should be considered for local investment because of its long term nature. Some opportunities exist during the development phase.

7.5.8 Aboriginal Considerations

The issues and concerns raised in the 1986 report are still valid. However, as outlined in Section 7.5.2 and 7.5.3, the fishery should not be at risk providing that the proper management systems are in place. In addition, fishery compensation policies are well established in the western world and should be in place prior to any drilling activity.

Since 1986, the issue of control by aboriginal groups over their destiny has been heightened as has significant consultation and participation in any major offshore project located in or adjacent to their settlement area.

The types of issues concerning large scale projects raised by aboriginal peoples in the last few years can be categorized, although they may differ from region to region. Below are significant issues regarding large scale developments which were raised by aboriginal groups on Canada's east coast and which need to be adequately addressed prior to any exploration drilling:

X aboriginal knowledge*
X air quality
X air traffic
X alcohol and drug abuse
X business opportunities

[2] The above analysis only considers direct employment. Theses direct jobs have indirect and induced employment multiplier effects, although these may be modest given what is likely to be high levels of "leakage" from the region.

X communications*
X community life*
X compensation*
X culture, land use and rights*
X cumulative effects*
X economic benefits/development*
X education
X employment and training*
X *environmental assess*sment*:
X process, methods, baseline *studies, protection plans*
X exploration
X family life
X fisheries
X harvesting and land use*
X health and safety
X historical resources and burial sites
X mitigation and monitoring*
X shipping*
X social problems*
X water
X wildlife*
X women's issues*

*significant issues as identified through public consultation

Today, aboriginal groups demand that they have significant say over any project located in their region. In many cases, their governing body issues guidelines for any research or work to be undertaken in their settlement area. As an example, the Labrador Inuit have issued ethical guidelines for research which outline the responsibilities of the researcher (s) and community or accountable agency which are expected to be adhered to by all parties. Of major importance is that initial approval by the lead aboriginal association must be obtained prior to undertaking any research, followed by consultation with the affected community as a whole and then on-going review, if the research proposal is accepted. Issues of social, gender and culture as well as on-going communication and consent must be addressed to ensure no conflicts occur. Of equal importance is the employment of local people who may help in the interpretation of activities and issues unique to that area. Finally, groups such as the Labrador Inuit state clearly that they want all research material and data to remain the property of the affected community and that they have the right to censor any sensitive material. Furthermore, all information must be translated into local languages.

In addition to the above research guidelines, aboriginal groups want employment on any projects occurring in their area. This includes any work in the pre-EIS stage of a major project. Also, partnerships, joint ventures and cooperatives involving aboriginal peoples will be created for the sole purpose of working on any proposed project. This, however, does not imply that opposition to a project will not occur. Risks will need to be mitigated or minimized, but at the same time aboriginals will want to maximize any benefits accruing from the project. If an offshore project successfully passes the environmental assessment review process, aboriginal groups will want to establish companies to maximize employment benefits. For example, translation services, catering, employment and

transportation companies are some types of companies that have been established by aboriginal groups elsewhere.

Aboriginal people may also wish to work offshore on drilling rigs and/or production facilities. Experience with the Beaufort Sea oil exploration program and, more recently, remote "fly-in" mines has shown how commute work schedules (whereby workers alternate between one or more weeks at the work site and similar periods in their home communities) allow industrial work to be combined with aboriginal lifestyles. It brings cash income into remote aboriginal communities while allowing the commuting workers blocks of time to spend in subsistence activity and traditional pursuits (Husbers et al, 1995).

While at the same time as wanting employment, aboriginal groups are adamant that their traditional lifestyle be protected from any harmful influences, be it disruption of a traditional burial ground, hunting pattern or social environment. Environmental assessments are mandatory at the production phase, but agreements are often worked out between aboriginal groups and companies at the exploration stage, if effects to the traditional lifestyle are perceived to occur. These agreement could follow the same type of guidelines as indicated above or as outlined in Section 7.5.3, Fisheries Compensation.

7.5.9 Social Effects

The 1986 report indicated that lifestyles could change as a result of a range of oil activity related impacts and that a range of positive and negative effects would likely occur.

The experience of developed countries since 1986 is that, given the use of conventional impact assessment and management approaches, the social impacts of exploration and production are limited and generally positive. Increased incomes and employment, allied to improved transportation services and company community investment programs, have positive direct and indirect consequences. While initial concern focuses on increased substance abuse, illegitimacy, crime and the cost of living, recent evidence suggests that increases are normally minor or non-existent. However, a danger exists that communities will damage their own social environment through speculative responses early in exploration or in the wake of a discovery. For example, this occurred in Newfoundland in the wake of the Hibernia discovery, with expectations of increased house prices becoming a self-fulfilling prophecy at a time when only minor direct industry effects occurred on the local housing market.

Wills (1991) and Freudenberg and Gramling (1994), in writing about the Shetland Islands and Louisiana respectively, conclude that offshore oil activity has generally had a positive effect on the local culture, and this finding would apply equally in Newfoundland and most other similar areas that have had oil industry involvements.

The main exception to this pattern has been in the development phase, which is potentially problematic given the size and short duration of some construction projects and, hence, the danger of 'boom and bust' impacts. The construction of the Trans-Alaska pipeline and Sullom Voe refinery are often cited as examples of such problems. However, these types of projects are becoming smaller and less common, and the Hibernia experience shows that they can be managed. A study of the Hibernia construction project concluded that it:

Successfully avoided the negative social and economic impacts

> normally associated with the superimposition of very large projects on rural environments... Hibernia stands out as a case where potential impacts were adequately identified, optimization measures determined and implemented, and the negative consequences avoided or mitigated. (Storey, Shrimpton and Grattan, 1996, p.271)

The primary mitigation strategy was housing non-local project workers in a high-quality, well equipped and well managed work camp, thereby making it unnecessary for workers to find accommodations or use services and other infrastructure in nearby communities.

As discussed previously, the socio-economic effects of closing a field are of short duration, while the end of activity in a region is relatively long-term and gradual. For this reason, the social effects are gradual and there is opportunity to prepare for them.

7.6 LESSONS LEARNED

Lessons learned from the offshore oil experience on Canada's East Coast clearly indicate that many of the perceived problems can be avoided with proper planning of the three major parties: the oil industry, government and communities. As an example, many of the anticipated concerns about the Hibernia project which arose during public hearings did not occur as evidenced by studies that were undertaken after the development phase was completed. That was in part a result of good management practices, but also because some of the concerns were unrealistic in the first place. Furthermore, much of the speculation about socio-economic effects was fuelled by local residents rather than by the oil companies. Nonetheless, one way for local jurisdictions to manage effects of oil and gas developments is to have proactive and positive management schemes in place that allow oil companies to explore and develop oil and gas fields, but only by adhering to realistic guidelines and regulations. These should be worked out between the three parties prior to any development. Examples are fisheries compensation and training needs. Lastly, it is important that local jurisdictions fully understand the various phases of oil and gas development and that realistic expectations and regulations are placed on the exploration phase, the most ephemeral phase of all.

7.7 INFORMATION/KNOWLEDGE GAP

No community, government or industry will ever be completely satisfied in how an oil and gas industry develops in a particular location. However, enough lessons have been learned from the international experience about the socio-economic effects of offshore oil and gas development that few knowledge gaps exist. The critical element is how well the three major players: industry, government and the community, can collectively manage the potential effects. For governments, it is important to have a petroleum board staffed with well trained people in the right disciplines. Communities need to understand the capability profile of their jurisdiction, match those capabilities with oil and gas industry needs and then build on those capabilities. Industry must understand and not underestimate the capabilities of the local jurisdiction.

8.0 CONCLUSION

In the intervening ten years since the 1986 *Report and Recommendations of the West Coast Offshore Exploration Environmental Assessment Panel* was produced, significant changes have occurred in the management of the offshore petroleum industry in Canada and elsewhere. While the offshore will always present risks to both the biophysical and

human environments, those risks have been substantially reduced though the introduction of new approaches to management, innovative information technology applications, new generations of offshore hardware and better cooperation among those operating and regulating the offshore.

As noted in the 1986 report, activity levels during the exploration phase are variable, with companies able to terminate their efforts for a variety of reasons including poor exploration results, better prospects elsewhere, a global recession in exploration, over demand for exploration rigs or a local jurisdiction being 'unreasonable' in its requirements for local preference, taxation and/or environmental protection. For these reasons, it is hard to "manage" the exploration phase, but global standards of safety have now been accepted in western countries and assuming that a federal/provincial offshore board is established in British Columbia, certain regulations and guidelines can be implemented for the exploration phase.

This study deals with both general and specific advances in the offshore. Changes of a more general nature or which are specific, but result in a greater effect on the offshore, governments and communities, include:

X improved three-dimensional seismic technologies which increase the success rate of exploratory drilling by more effectively identifying likely prospects and, consequently, result in more efficient drilling as well as reduced time between start-up exploration and subsequent development activity (if any);

X increased efficiency during seismic surveying and exploratory drilling which shortens the time in the field as well as limits local participation and impacts, both positive and negative;

X increased globalization resulting in operators becoming more aware of the range of prospects available worldwide as well as the requirements to become internationally competitive, and

X pooling of resources by companies operating in a region resulting in sharing supply bases, transportation systems, drilling rigs and some personnel which may limit local participation, but will allow exploration to become more economically viable.

Specific advancements have occurred at all levels in the offshore. While the study 's discussion of those advancements is not exhaustive, it does provide an overview of those which would be of primary interest to British Columbia.

Today, safe operations in harsh physical environments is achievable through the use of information technology systems in which accurate forecasts based on hindcasts, verifications and improved forecasting tools are regularly produced or available for almost any given geographical area. Offshore research related institutes are now located both in eastern and western Canada which allow the testing of offshore assets, such as drilling rigs, in a variety of weather and sea state conditions. The increasing use of Geographical Information System results in various ocean users having a clear understanding of each other's activities and possible interactions. British Columbia has been a leader in this regard and those individuals and agencies possessing this knowledge have much to contribute to the offshore industry, should the moratorium be lifted. In the last ten years communication systems between seismic and support vessels, helicopters and offshore drilling platforms

have substantially improved. Various well planned and practised systems are in place for dealing with emergencies. Environmental Assessments have also become more rigorous with the result that all risks are identified and dealt with prior to production. Finally, legislation and guidelines have been developed, tested, implemented and enforced, where necessary. Of importance in British Columbia is the National Energy Board's 1994 *Guidelines Respecting Physical Environmental Programs during Drilling and Production Activities on Frontier Lands* which have been accepted by both C-NOPB and C-NSOPB.

Engineering advancements for all upstream phases of the petroleum industry have occurred over the last ten years. Of particular importance to British Columbia is the improved efficiency in gathering seismic data which provides more precise information regarding the likely presence and location of hydrocarbons. This advancement, in turn, helps engineers select the most appropriate drilling system and well design. Exploration drilling has also significantly improved in the control of spillage, the venting of hydrocarbons and drilling fluids, the handling of heavy loads and materials and the safety management of drilling operations. The two categories which have seen perhaps the greatest improvements are environmental systems and procedures as well as overall management of the asset including offshore facilities and support systems. Actual equipment and technologies have vastly improved for BOP's, marine risers, recycling of marine fluids, non-toxic drilling muds, drilling equipment design, control and feedback, and back-up systems, to name a few.

Risk management has undergone a complete change in philosophy over the last ten years. Today, safety is integral to each production operating unit and is integrated into the conceptual and detailed design phase as well as in all management systems, rather than being added on afterwards as was previously the case. As well, a holistic approach to safety analysis has been adopted by all operators and regulators. Today, the concept of Quantified Risk Analysis in association with Cost Benefit Analysis has been developed and refined to ensure that an operator can demonstrate that risk to personnel, all offshore facilities and support services and the environment has been reduced to as low as is reasonably practicable. Furthermore, legislation emanating from the various offshore petroleum boards has become far more stringent in the protection of personnel, facilities and the environment.

The exploration phase, including seismic surveying and exploration drilling, for any offshore field program is of short duration and involves the use of mobile "standard" equipment that is used worldwide. Standard practice guidelines and regulations which apply throughout the western world have been accepted and followed by operators. These are generally prescriptive regimes which can regulate this short term mobile market place more easily than a production regime which is based on the unique characteristics of the region and a production time table of upwards of twenty years.

A heightened awareness of the importance of environmental protection has been a major focus for both regulators and offshore operators over the last ten years. Most operators have in place a total loss management system which encompasses all programs and activities associated with health, safety, environment, reliability, process hazard management, risk assessment and loss prevention. Incremental advances have been made in the ability to predict oil spill trajectories as well as in the ability to determine effects of oil spills and remediation techniques. This information is directly applicable to northern British Columbia. While few offshore blowouts have occurred and major incidents involving released material into the ocean have also been few, information about the possible effects has increased. Environmental effects monitoring is perhaps one of the best

tools for ensuring that the industry adheres to established environmental guidelines and/or regulations. However, cumulative impacts on specific species and on the general ecosystem are still inadequately and imperfectly understood.

Just as changes in managing risks and environmental protection have occurred in the last ten years, new strategies for the management of the socio-economic effects have also occurred. Federal and provincial jurisdictions need mechanism for managing the effects of the offshore. In Canada, this has been achieved through the establishment of federal/provincial offshore boards, but local jurisdictions can also exert control through management of critical offshore components such as airports or harbours. There has also been a move towards focused environmental assessments, socio-economic and environmental protection plans and increased understanding of the industry, its various phases and spin-offs. Governments, the industry and communities have also matured and work together to achieve results which are in the best interest of all parties. Today, it is not so much, 'can the fishing and oil industries co-exist", but more often, "how fishing and oil industries co-exist". One method has been through effective and focused monitoring of activities and subsequent effects which provide critical and timely feedback about the positive and negative effects of a project.

A key interest to the British Columbia government will be the balance between resource revenues and direct economic benefits. Most governments take a position between these extremes, based on such factors as jurisdictional powers, economic and political priorities and, on the east coast of Canada, equalization. In both Newfoundland and Nova Scotia, equalization predisposed the provincial governments towards seeking to maximize direct benefits which helped in diversifying the region's economy. Based on pre-and post-development studies of the Hibernia field, negative effects of the project were substantially reduced from what was anticipated. This was partially a result of a continuous flow of appropriate information between communities, regulators and the operator.

Critical to the success of managing any new industry is the development of trust between all parties which is achievable through effective communications and information over a long time period. This trust will enable all concerned parties to solve challenges before they become major problems. In the absence of reliable, effective communications and information, people will manufacture their own and, as has been proven by Hibernia, speculation about socio-economic effects is often fuelled by local residents rather than by oil companies and many of the concerns are unrealistic in the first place.

Despite all the regulations and guidelines, statistics show that most accidents are a result of human error. Therefore, both competent, knowledgeable regulators as well as operators will continue to be required for all phases of the offshore industry.

In conclusion, since the publication of the 1986 *Report and Recommendations of the West Coast Offshore Exploration Environmental Assessment Panel*, substantial advancements have been made by both the regulators and industry to minimizing those risks associated with the offshore petroleum industry in Atlantic Canada, Norway and the United Kingdom. As well, in the intervening ten years since the report was produced, communities have become far more knowledgeable about the industry and its potentially negative and positive effects. This growth in knowledge has led to a much more effective industry with good checks and balances in place. Therefore, a long term communications program among the three major stakeholders: government, industry, and the community, will be the key to a successful offshore petroleum industry in British Columbia should the moratorium

be lifted.

British Columbia has taken a proactive step by tracking and updating issues emanating from the 1986 report. This study can serve as a bench mark for measuring on-going advancements of issues of continuing importance and concern to the residents of British Columbia.

APPENDIX A
REFERENCES

APPENDIX B
RISKS AND BENEFITS OF OFFSHORE OIL ON GEORGES BANK AS PERCEIVED BY RESIDENTS OF NOVA SCOTIA

APPENDIX C
MARINE DATA

APPENDIX D
WORLDWIDE OIL SPILL DATA